CALFED Bay-Delta Program

Ecosystem Restoration Program

Conservation Strategy for Stage 2

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Background

The CALFED Bay-Delta Program (CALFED) is a 30-year Federal and State program to fund and implement fish and wildlife restoration efforts in California's Bay-Delta and Central Valley, while assuring water quality, water supply reliability, and levee stability for all uses. The CALFED Ecosystem Restoration Program (ERP) is intended to improve the health of the Bay-Delta system through restoration and protection of native species and their habitats. The ERP Implementing Agencies are the U.S. Fish and Wildlife Service (FWS), California Department of Fish and Game (DFG), and NOAA's National Marine Fisheries Service (NMFS), collectively referred to as the ERP Implementing Agencies.

As provided for in the 2000 programmatic biological opinions (PBOs), Programmatic Environmental Impact Statement/Environmental Impact Report (PEIS/EIR), and Record of Decision (ROD), CALFED agreed that its first stage (Stage 1) would last seven years, after which the next stage (Stage 2) would be collaboratively determined by the CALFED agencies. To this end, the ERP is conducting a set of evaluations to ascertain progress on restoration and regulatory compliance during Stage 1 and inform conservation planning for transitioning into Stage 2. The evaluations also will identify other related programs and planning efforts that need to be coordinated with ERP planning, and encourage involvement of the other programs, stakeholders, and public. The evaluations include:

- Progress towards achieving Multi-Species Conservation Strategy (MSCS) Milestones
- Progress of ERP Program Plan (ERPP) implementation
- Progress towards achieving specific actions identified in the ROD
- Progress towards achieving Key Planned Actions provided for in the PBOs
- Efficacy of the Environmental Water Account (EWA)

Based on outcomes of Stage 1 evaluations, review of present ecological conditions, coordination with related programs and planning efforts (e.g. the Bay-Delta Conservation Plan, Delta Vision, and Delta Risk Management Strategy), assessment of potential future actions, and input from stakeholders and public, the ERP Implementing Agencies, will develop a Stage 2 conservation strategy. The conservation strategy will comprise specific biological elements (e.g. goals, objectives, and priorities for species and habitats), as well as a programmatic framework under which the strategy can be implemented (e.g. updated ERPP, updated regulatory provisions, and a revised monitoring, tracking, and adaptive management structure).

The ERP has several key documents that outline the present program. These include the ERPP, Volumes 1 and 2; Strategic Plan for the Ecosystem Restoration (Strategic Plan); and MSCS. The conservation strategy for Stage 2 is intended to build on these plans.

Ecosystem Restoration Program Plan

Volume 1 of the ERPP describes the organization of the program, visions for ecological processes and functions, fish and wildlife habitats and species, and stressors that impair the health of the processes, habitats, and species. The visions presented in Volume 1 are the foundation of the ERP and display how the many ecosystem elements relate to one another. Volume 2 presents visions for the 14 ecological management zones (Appendix A) and their respective ecological management units. Each ecological management zone vision contains a brief description of the management zone and units, important ecological functions associated with the zone, important habitats, species that use the habitats, and stressors that impair the functioning or utilization of the processes and habitats. Volume 2 also contains restoration targets, programmatic actions, and conservation measures that describe the ERP approach, and that balance and integrate needs of the MSCS. Rationale also is contained in Volume 2 that clarifies, justifies, and supports targets and actions.

Multi-Species Conservation Strategy

The MSCS provides a two-tiered approach for CALFED to meet requirements of the Federal Endangered Species Act (FESA) California Endangered Species Act (CESA), and the Natural Community Conservation Planning Act (NCCPA). The first tier is a program-level evaluation of CALFED similar to Programmatic Environmental Impact Statements under NEPA and CEQA. The second tier is the project-level evaluation in a process in which an Action Specific Implementation Plan (ASIP) is prepared for each CALFED action or groups of related actions proposed for implementation. The MSCS includes evaluations of potential impacts on specified biological resources of implementing CALFED. These include:

1. Identification and evaluation of 244 special status species and 20 NCCP communities that could be affected by CALFED within the program problem/solution area;
2. Identification of conservation goals for each of the 244 evaluated species and 20 NCCP communities;
3. Identification of two types of conservation measures contributing toward achieving species and community goals:
    a. Measures to avoid, minimize, and compensate for adverse effects on NCCP communities and evaluated species caused by individual CALFED actions and
    b. Measures to enhance NCCP communities and evaluated species that are not directly linked to CALFED's adverse effects; and
4. Evaluation of effects of implementing CALFED actions and conservation measures identified in the MSCS for the 244 evaluated species and their FESA designated critical habitats and 20 NCCP communities.

Implementation of all the CALFED actions evaluated in the MSCS and conservation measures over the 30 year project period are expected to result in:

1. Recovery of populations of 19 evaluated species ("R species");
2. Partial recovery of populations for 25 evaluated species ("r species");
3. Measurable benefits for populations and habitats for 45 evaluated species
4. Maintenance of existing levels of populations and habitats for 155 evaluated species ("m species");
5. Substantial increases in the extent and quality of 12 NCCP communities;
6. Protection, enhancement, or restoration of four NCCP communities;

7. Minimization of loss, and maintenance or increase, of wildlife habitat values provided by upland, cropland, and seasonally flooded agricultural lands; and
8. Minimization of loss of grassland and upland scrub.

Ultimately, the goals, prescriptions, and conservation measures of the MSCS were incorporated into, and made components of, the ERPP. A crosswalk was developed to reconcile terminology differences.

Strategic Plan

The Strategic Plan provides ERP goals and objectives and the scientific and practical framework for implementing the restoration of the Bay-Delta watershed. There are six strategic goals that define the scope of the program. These are further divided into more-specific strategic objectives, each of which are intended to help determine whether or not progress is being made toward achieving the respective goal. Specific actions based on the ERPP Volumes 1 and 2 also are identified in the Strategic Plan.

Goals and Objectives

The ecosystem goals and objectives were developed by a diverse group of representatives from CALFED agencies, academia, and the stakeholder community. The goals and objectives provide a guide for achieving a reasonable level of ecosystem quality for the Bay-Delta system in a way that reduces conflicts among beneficial uses of California's water. The key term "ecosystem quality" is not well defined but is presumed to equate to "ecosystem health" and "ecosystem integrity" (e.g. Woodley et al. 1993). All of these terms imply the desirability of ecosystems that not only will maintain themselves through natural processes with the minimal human interference possible, but also will be aesthetically attractive and produce goods and services in abundance for humans. Thus, the overall goal can be stated as "to achieve recovery of at-risk species and rehabilitate and restore natural process and functions to the maximum extent practical within the Bay-Delta estuary and its watershed."

The ecosystem restoration goals and objectives help develop and organize the numerous components of the ERP. Goals provide the basis for a vision of a desired future condition of the Bay-Delta system. Neither the goals nor objectives are intended to change over time except with a significant change in policy direction or new scientific information. The ERP addresses these strategic goals through restoration of ecological processes associated with streamflow, stream channels, watersheds, and floodplains. These processes create and maintain habitats essential to the life history of species dependent on the Delta. In addition, the Program aims to reduce effects of stressors that inhibit ecological processes, habitats, and species. The Strategic Plan identified the following goals (paraphrased for brevity) for ecosystem restoration:

1. Achieve recovery of at-risk native species in the Delta and Suisun Bay and tributaries.
2. Rehabilitate natural processes in the Bay-Delta estuary and its watershed, with minimal human intervention, to support natural aquatic and associated terrestrial biotic communities and habitats, to favor native species of those communities.
3. Maintain and/or enhance populations of selected species for sustainable commercial and recreational harvest, consistent with the other ERP goals.

4. Protect and restore functional habitat types in the Bay-Delta Estuary and its watershed for ecological values.
5. Prevent the establishment of additional non-native invasive species and reduce the negative ecological impacts of currently established species.
6. Improve and or maintain water and sediment quality conditions that fully support healthy and diverse ecosystems.

Objectives are specific measures of progress toward meeting the goals. A complete list of goals and associated objectives are included in Appendix B. In ERPP Volume 2, one or more targets are identified for each objective. Targets are quantitative (e.g. range of numbers) or qualitative (e.g. narrative description) statements of what is needed in terms of the quality or quantity of desirable ecosystem attributes to meet the objectives. Targets are something to strive for but may change over the life of the program. Over 600 programmatic actions also are identified in ERPP Volume 2 and represent the specific implementation measures required to meet targets.

Since completion of the Strategic Plan, implementation of restoration activities has progressed but the objectives, particularly of protecting and recovering at-risk aquatic species, have not been achieved. In fact some of these species have further declined, such as species of the Pelagic Organism Decline (POD) in the Delta (e.g. delta smelt, longfin smelt, threadfin shad, and striped bass; neither threadfin shad nor striped bass were slated for protection or recovery under the MSCS). However, progress is being made in other instances, such as increased fall-run Chinook salmon in Clear Creek, Battle Creek, Feather River, and American River; and spring-run Chinook in Butte Creek (albeit, hatchery contributions to fall-run increases in some streams is unknown.)

Project Selection Criteria

Criteria are presented in the Strategic Plan to provide a foundation for project selection. However, indiscriminate evaluations focusing on how many criteria are met does not necessarily result in the most effective projects for meeting the highest priority actions. Thus, it is important that these criteria be weighted.

Stage 2 Conservation Strategy

The conservation strategy described here presently is limited to portions of the CALFED focus area, namely the Sacramento-San Joaquin Ecological Management Zone EMZ) and Suisun Bay and Marsh Ecological Management Unit (EMU) of the Suisun Marsh/North San Francisco Bay EMZ. The ERP's decision to select and limit its conservation planning to these areas for the near term was due to the emergence of the several ecological concerns and concurrent conservation planning efforts mentioned above (DRMS, Delta Vision, and BDCP) that will directly and significantly affect ecological processes, habitats, stressors, and species in the Delta and Suisun Marsh area. These areas are combined into a single focus area, the Delta-Suisun Marsh Planning Area, based on similar ecosystem components and functions. The remaining CALFED EMZs and EMUs will be addressed in the future, as the ERP strategy evolves and becomes a Bay-Delta watershed-wide conservation plan.

Delta-Suisun Marsh Planning Area

Introduction

Because CALFED is reaching the end of Stage 1 of implementation and is moving into Stage 2, and in response to indications that through-Delta conveyance is not working well (as partly evidenced by the POD), and issues exist regarding levee security, water supply reliability, climate change and sustainability of the Delta, planning activities have been initiated by several entities, including the ERP, to more specifically focus on Delta-Suisun Marsh issues. These activities include the Delta Risk Management Strategy (DRMS), Delta Vision, and the Bay Delta Conservation Plan (BDCP).

To help provide guidance for these activities, assess the potential ecological consequences of the findings of DRMS and Delta Vision, and inform CALFED Stage 2 conservation activities, an updated ERP biological vision, or conservation strategy for the Delta and Suisun Marsh is needed that reflects changing knowledge, conditions, and understanding of the system. It is intended that this strategy to be more explicit about the types and locations of actions needed to meet the goals and objectives in the Strategic Plan.

In developing the Stage 2 conservation strategy for the Delta-Suisun Marsh Planning Area, a primary consideration is whether ecosystem restoration can be achieved through maintenance of existing infrastructure and operations, or if evaluating alternatives that can accommodate and re-establish natural processes is needed. A primary impediment to re-establishment of natural physical and biological processes is use of the Delta as part of a water supply conveyance system. An acceptable alternative conveyance system must ensure that patterns of flow through the tributaries and through the Bay-Delta provide for natural physical processes and species recovery.

In conjunction with re-establishment of natural physical processes and species recovery, protection and restoration of functional habitat is needed to re-establish biological productivity of the system. Recent restoration considerations for the Delta include providing a more variable Delta. Variability can be expressed in several ways, including salinity, temperature, depth, and residence time of water, flow regimes that mimic natural conditions, and heterogeneity in habitat types and structure. Providing for variability that more closely mimics natural conditions should help improve biological productivity in the Delta and could help resolve conflicts with water operations.

Future Conditions and Ecosystem Response

In developing an updated conservation strategy, the ERP agencies acknowledge that potential changes in environmental conditions in the future can affect plant and animal species and their habitats. Potential threats include soil subsidence (sinking to a lower level), sea level rise, change in climate and precipitation patterns, catastrophic events, invasive species and food web changes, upstream and in-Delta water development, upstream and in-Delta urbanization and population growth.

Many of these threats, termed “first-order drivers of change,” were described by Mount et al. (2006) and are expected to influence future resource management in the Delta. For each of the six drivers, critical certainties and uncertainties have been identified for consideration within the context of various Delta planning efforts:

- Subsidence. Reclamation of the Delta marsh for agriculture has resulted in substantial subsidence of some islands, such that elevations of land in the central and western Delta are well below sea level. Subsidence of Delta islands is expected to continue as long as non-flooded agriculture remains the primary land use on areas with peat soil. Subsidence increases the differential between water surface elevation in channels and land elevation and increases instability of the levees protecting the islands. Flooded islands would be expected to reduce both water and habitat quality. Depth of subsided islands makes restoration of tidal freshwater marsh habitat very problematic, as quality of open water habitat on these deeply subsided islands would be expected to be low for native species.

- Sea Level Rise. Delta hydrodynamics are heavily influenced by tides, and sea level is a key determinant of tidal influence in the Delta. Global climate change is expected to increase sea levels and temperatures, as well as local weather patterns. As sea level rises, intrusion of brackish water into the Delta is expected to increase, exacerbating the differential between water surface elevation in channels and land elevations in Delta islands. It is generally predicted that rising sea level will negatively affect Delta hydrodynamics and habitat conditions.

- Regional Climate Change. Global climate change influences local climate conditions, particularly temperature and precipitation patterns, with implications for future inflows from tributaries to the Delta. In California, changes in precipitation patterns (i.e. more rain and less snow) are expected to shift timing of tributary peak runoff from spring to winter. It is projected that extreme winter runoff events will become more frequent and intense, and freshwater inflows to the Delta in spring and summer will decrease; greater variations in flows between years are also expected. Cumulatively, these changes are expected to put additional pressure on the Delta's fragile levees and increase the intrusion of brackish water into the Delta, with corresponding declines in both water and habitat quality.

- Catastrophic Events. The Delta is located in the vicinity of several active faults, with recent estimations of a 2-in-3 probability of a large magnitude earthquake within the next 30 years. Multiple levee failures and consequential island inundation are anticipated. Anticipated rapid flooding of subsided islands in the western and central delta would increase intrusion of brackish water into the Delta, resulting in significant changes in distribution, type, and quality of habitat.

- Invasive Species. Extensive invasion of the Bay-Delta estuary by non-native species has impacted ecosystem processes. Non-native species directly compete with natives for food, or have so significantly altered the food web that native species are food-limited. Exotic plants and weeds have significantly changed native aquatic habitats by altering substrate, food/light availability, and/or water quality constituents (such as dissolved oxygen). Introductions of new invasive species are inevitable. Restoration activities will need to be monitored and adaptively managed in response to unavoidable impacts on the Delta ecosystem.

- Urbanization and Population Growth. The Delta is surrounded by some of the most rapidly urbanizing areas in California; this urbanization has resulted in increased runoff to Delta

> waterways, and has increased infrastructure in the Delta that serves urban areas outside the Delta. Population growth in other areas of California is increasing demand for irrigation and drinking water supplies from the Delta. Rapidly growing demand for Delta resources may not be sustainable, particularly with respect to accommodating native species, and it will likely become increasingly difficult for resource managers to balance needs in the future.

Incorporating threat considerations into a conservation strategy would require a risk analysis that could quantitatively assess uncertainties related to the threats. Uncertainties are difficult to assess, as they are complicated by randomness of events in nature and lack of knowledge (e.g. information, scientific understanding, and quantitative data). The ERP agencies are presently considering possibilities for conducting a risk analysis that would inform future updates to the ERP conservation strategy. It is expected that such an analysis would require a significant amount of time and funding to complete. The ERP agencies will continue to address risk analysis needs as CALFED moves from Stage 1 into Stage 2.

Description of the Delta-Suisun Marsh Planning Area

Sacramento-San Joaquin Delta Ecological Management Zone
The Sacramento-San Joaquin Delta EMZ is defined by the legal boundary of the Sacramento-San Joaquin River Delta. It is divided into four regional EMUs: North Delta, East Delta, South Delta, and Central and West Delta EMUs.

The Delta is the easternmost portion of the San Francisco Bay-Delta Estuary, and is clearly delineated by a legal boundary that includes areas that historically were intertidal, along with supratidal portions of the floodplains of the Sacramento and San Joaquin rivers. Today's legal Delta extends between the upper extent of the tidewater (near the city of Sacramento on the Sacramento River and Mossdale on the San Joaquin River) and Chipps Island to the west, and encompasses the lower portions of the Sacramento and San Joaquin river-floodplain systems as well as those of some lesser tributaries (e.g. Mokelumne River and Calaveras River). Once a vast maze of interconnected wetlands, ponds, sloughs, channels, marshes, and extensive riparian strips, the Delta now consists of islands of reclaimed farmland protected from flooding by hundreds of miles of levees. Remnants of the tule marshes are found on small channel islands or shorelines of remaining sloughs and channels.

The Sacramento-San Joaquin Delta EMZ is characterized primarily by agriculture with a mosaic of smaller natural habitats that support the system's fish, wildlife, and plants. Instream and surrounding topographic features influence ecological processes and functions and are major determinants of aquatic community potential. Both quality and quantity of available habitat affect structure and composition of the Delta's biological communities. Much of the remaining natural habitats consist of small, scattered and degraded parcels.

Less than Five percent of the Delta consists of riparian, oak woodland, fresh emergent wetland, and seasonal wetland habitats. Much of the remaining riparian and wetland habitat is found in the Yolo Bypass, Cosumnes River Preserve, and Stone Lakes area in the North Delta EMU; along the Cosumnes and Mokelumne rivers and in the White Slough Wildlife Area in the East Delta EMU; in narrow bands along the San Joaquin River and on small channel islands in Old

River in the South Delta EMU; and on the network of small channel islands in Old and Middle rivers, on White, Potato, and Disappointment Sloughs, along the edges of Big Break and Franks Tract, on the Lower Sherman Island Wildlife Area, and on tide lands of the Sacramento River channel in the Central and West Delta EMU.

Important aquatic habitats are severely limited by levees and flood control systems. Remaining aquatic habitats in the Delta include shaded riverine aquatic (SRA) habitat; vegetated and non-vegetated shallow shoal areas; open-ended sloughs, both large and small; and small dead-end sloughs. The large, open river channels of the Sacramento and San Joaquin rivers in the central and western Delta are more like tidal embayments of Suisun Bay to the west of the Delta. Areas with SRA habitat are fragmented and subject to excessive erosion from wind- and boat-generated waves. Shallow shoal areas are small and fragmented and are subject to excessive water velocities and periodic dredging that degrade or scour them.

Hydraulic processes in the Delta are influenced by tides, river inflow, weather, channel diversions, upstream water releases, and temporary rock barriers. Unimpeded tidal action into tidal wetlands affects the habitat's sediment and nutrient supplies. These supplies influence the natural marsh successional processes. Tidal outflows transport nutrients and carbon into Bay-Delta aquatic habitats. Hydraulic processes have been modified in the Delta since the 1800s. Reductions in flow from the Mokelumne River began in the late 1800s and continued to decline into the 1960s. The construction of the Yolo Bypass significantly altered hydraulic patterns during above normal and wet water years. The Delta Cross Channel (DCC) gates began operating in 1951 and increased the flow of Sacramento River water into the East Delta EMU and away from the mainstem Sacramento River. Completion of the Hetch Hetchy Aqueduct in the 1930s resulted in further reduction in from the Tuolumne River. In the early 1940s, construction of Friant Dam began to alter hydraulic patterns significantly, particularly during drier water years. The South Bay Aqueduct began diversions directly from the South Delta EMU starting in 1962. Deliveries to the Contra Costa Canal began in 1962 directly from Rock Slough. Hydraulic patterns have been further modified by the significant export pumping, which began in 1951 for the CVP and in 1968 for the SWP.

Current hydraulic conditions in the Delta are unhealthy. These conditions reduce the ability to provide suitable residence times and more natural net flows; to provide adequate transport flows to the central and west Delta and the entrapment zone; and to support high-quality rearing and spawning habitat, nutrient cycling, and foodweb integrity.

Land elevations in the Delta generally range from 25 feet below to 10 feet above mean sea level. Lower elevations are generally found in the central part of the Delta with higher elevations found on the periphery. Elevation is an important factor in evaluating the quality of habitats and in designing habitat restoration projects.

North Delta Ecological Management Unit. The North Delta EMU is bounded on the south and east by the Sacramento River. Notable features are the Yolo Bypass, the Sacramento deep water channel, the Cache Slough complex the Sacramento River and adjoining sloughs, the Snodgrass Slough and Stone Lakes complex, and the DCC gates.

East Delta Ecological Management Unit. The East Delta EMU is bounded on the northwest by the Sacramento River; on the northeast by the Mokelumne and Cosumnes rivers; and on the south by Highway 12, the South Fork of the Mokelumne River, White and Disappointment Sloughs, and the San Joaquin River. Notable features are Georgiana Slough, the DCC, the Cosumnes River Preserve, and the Woodbridge Ecological Reserve. It contains both forks of the Mokelumne River, the Cosumnes River, three dead-end sloughs (Beaver, Hog, and Sycamore), and important waterfowl wintering and sandhill crane foraging and roosting areas.

South Delta Ecological Management Unit. The South Delta EMU is bounded on the north by the San Joaquin River, Turner Cut, Whiskey Slough, Trapper Slough, Victoria Canal, and Italian Slough. Notable features are the San Joaquin, Old, and Middle rivers; Clifton Court Forebay; and the State and federal fish protection and export facilities.

Central- West Delta Ecological Management Unit. The Central and West Delta Ecological Management Unit is bounded on the west and north by Suisun Bay, the Sacramento River, Highway 12, the South Fork of the Mokelumne River, and White and Disappointment Sloughs; and on the south by the San Joaquin River, Turner Cut, Whiskey Slough, Trapper Slough, Victoria Canal, and Italian Slough. Notable features are the San Joaquin and Sacramento rivers, Franks Tract, the channel islands in Middle and Old rivers, and Potato and Disappointment Sloughs. The central and west Delta has some of the highest levels of wintering waterfowl within the Delta. They use seasonally flooded croplands on the deeper islands in this unit. The California Department of Water Resources is one of the most significant landowners in this unit owning most of Twitchell and Sherman islands.

Suisun Bay and Marsh Ecological Management Unit
The Suisun Bay and Marsh EMU is one of five units in the Suisun Marsh/North San Francisco Bay EMZ. It is adjacent to and west of the Sacramento-San Joaquin Delta EMZ, between the confluence of the Sacramento and San Joaquin Rivers and San Francisco Bay in southern Solano County. It includes approximately 30,000 acres of open water sloughs and bays, 54,000 acres of managed marsh, 13,500 acres of tidal marsh, and 27,000 acres of upland grassland. The Marsh contains about 10 percent of the remaining wetlands in the State and is the largest brackish marsh.

The boundaries of the Suisun Bay and Marsh Ecological Management Unit are Collinsville on the east, the Contra Costa County shoreline to the south, the Benicia Bridge to the west, and the ridge tops of the Coast Ranges to the north. The marshland and bay are in a valley, bordered on the north and south by the Coast Ranges. The predominant habitat types in this unit are tidal perennial aquatic habitat, tidal brackish emergent wetland, seasonal nontidal wetland, seasonal brackish managed marsh and grassland. The marsh is primarily a managed wetland, with levees to control water level and seasonal flooding with fresh water to balance soil salinities.

Historically, the eastern portion of Suisun Marsh was predominantly tidal fresh and brackish water marsh. The western portion of the marsh was predominately fresh and brackish marshland with more saline marsh existing on the western edge. Within these broad marshes were sloughs, channels, ponds, and small bays. Except for parts of Suisun Bay, the segment had relatively few tidal flats. Large areas of moist grasslands connected the baylands with upland areas.

As a result of the federal and state legislation encouraging the reclamation of “swamp lands,” the marsh was engineered so that it is now surrounded and transected by a complex of levees. Reclamation actions reduced tidal marsh and tidal flat habitats from 68,000 acres in the 1800s to about 15,000 acres, presently. Some areas were leached to remove salts and were farmed for crops, but the majority of the reclaimed areas were used as pasture for cattle and flooded seasonally for waterfowl hunting. This flooding regime gradually favored vegetation that displaces the native salt grass and pickleweed. The largest intact undiked wetlands remaining in Suisun Marsh are associated with Cutoff Slough and Hill Slough in north central Suisun Marsh.

An extensive network of sloughs conveys tidal flows and some freshwater flow into the marsh. Montezuma Slough, the largest of these, is connected to Suisun Bay at its eastern and western ends. The slough is an important nursery area for many fish, including Chinook salmon, striped bass, splittail, and delta smelt. The Suisun Marsh Salinity Control Structure was constructed near the eastern slough entrance and began operation in the fall of 1988 to limit the tidal influx of saltwater from the Bay into Suisun Marsh. The salinity control structure operates from September through May by closing during flood tides and opening during ebb tides to keep salinity in the slough low throughout the managed wetland flooding season.

Ecological Issues Pertaining to the Delta-Suisun Marsh Planning Area

Sacramento-San Joaquin Delta Ecological Management Zone
Ecological factors having the greatest influence on Delta fish and wildlife include freshwater inflow from rivers, water quality, water temperature, channel configuration and hydraulics, wetlands, riparian vegetation, and diversity of aquatic habitat. Stressors include water diversions, channelization, levee maintenance, flood protection, placement of rock for shoreline protection, poor water quality, legal and illegal harvest, wave and wake erosion, agricultural practices, conversions of agricultural land to vineyards, urban development and habitat loss, pollution, and introductions of non-native plant and animal species.

Land reclamation and levee construction have eliminated much of the natural Delta floodplain, forcing waters rapidly to exit the Delta through confined channels. Flood flows that once spilled into a vast floodplain are now confined to narrow channels. Existing hydraulic conditions inhibit the function of Delta channels as migration corridors and rearing habitat for salmon and other anadromous fish, including steelhead, striped bass, American shad, white sturgeon, and green sturgeon, as well as inhibit food-web production. Remaining channels and sloughs have been modified to become water conveyance “facilities” and flood control features, resulting in elevated water velocities and loss of structural diversity.

Central Valley water supply and hydroelectric projects have had a large effect on the freshwater flow through the Delta. Spring flows at present remain much lower than pre-project conditions. Summer inflows are manipulated via reservoirs to keep saltwater from entering the Delta and to satisfy demands for water diversions. Winter flows have fallen because much runoff from winter rains is now stored in foothill reservoirs. Water diversions from the Delta may reduce outflows by as much as 14,000 cubic feet per second (cfs). In addition, lack of adequate screening and location of water diversions in sensitive areas of the Delta contribute to the loss of important fish and aquatic foodweb organisms.

Reductions in spring freshwater flow into the Delta and loss of riparian vegetative cover, as well as agricultural and other discharges into the Delta, have led to slightly increased water temperatures. Agricultural and other discharges have also increased Delta water temperatures. Loss of tidal marshes (historic tule marshes) to agricultural conversion probably constituted one of the greatest causes of lost productivity and change in the aquatic foodweb. Along with loss of tidal marshes in the Delta came loss of shallow-water aquatic habitats (e.g., small sloughs and ponds) where many native resident and anadromous fish and estuarine invertebrates depend on these habitats.

In many areas, agricultural lands have become surrogate habitat for wildlife, partially replacing native habitats. Agricultural lands have important benefits for wildlife in the Delta, but are not a substitute for natural habitat. After more than 100 years of land reclamation activities in the Delta, many linear miles of natural sloughs have been lost. In addition, levee construction and bank protection have led to the loss of riparian, wetland, and more shallow-water habitat. Other activities such as dredging, disposal of dredge materials, and release of toxins into the system, have contributed to degradation of aquatic habitat and have had adverse effects on health, survival, and reproduction of many important Delta fish and their foodweb organisms.

Accidental introduction of many marine and estuarine organisms from ballast waters of ships from the Far East has greatly changed composition of plankton and benthic (bottom and shore dwelling) invertebrates of the Delta, with further effects on the foodweb. In addition, numbers of predatory fish have increased at certain locations in the Delta. Losses of some resident and anadromous fish to predation may limit their recovery. Predators may reduce populations and ultimately limit recovery of important fish species. Other possibly stressors to Delta species include legal and illegal harvest of fish populations; increased boat traffic, which contributes to erosion of remaining shallow water, riparian, and wetland habitat; as well as associated degradation of water quality from fuel and oil spills.

Suisun Bay and Marsh Ecological Management Unit

Ecological processes essential to a healthy Suisun Marsh and San Francisco Bay include Bay-Delta hydraulics, freshwater inflow, flood and floodplain processes, and aquatic foodweb processes. Separation of wetlands from tidal flows and reclamation of emergent wetlands have altered ecological processes and functions in Suisun Marsh. Removing tidal action from marsh and bayland soils has caused oxidation in soils and subsidence of interior islands, adversely changed wetland soil chemistry, prevented accretion of bottom sediments necessary to keep up with sea level rise, reduced nutrient input to this zone, and reduced output of other organics and fixed nutrients. Losing these processes and functions has reduced available habitat for native species of fish, plants, and wildlife; reduced water quality; and decreased area available for dispersing flood waters and depositing suspended silt.

Suisun Marsh is subject to many stressors present in the Delta. Stressors have had a significant effect on species and processes within the marsh. Aquatic foodweb productivity has declined over the past several decades due to several factors, including loss of tidal exchange, changes in freshwater inflow, adverse Delta conditions, water diversions, water quality, and introduction of exotic species.

Land conservation efforts in the 1970s resulted in the Suisun Marsh Protection Act which has played a key role in reducing development pressure and other adverse impacts on the marsh associated with human disturbance, such as accidental fires, careless application of pesticides and herbicides, and urban runoff. However, natural habitat that existed within the marsh; such as tidal fresh and brackish water marsh, saline marsh, sloughs, channels, ponds, small bays, a few tidal flats, and transitional grasslands; have been significantly altered after more than 100 years of human activities. Remaining marsh is primarily managed wetland, with levees to control water level and seasonal flooding.

Great numbers of fish and aquatic invertebrates are lost to unscreened or poorly screened water diversions. In addition to organisms, diversions remove disproportionately large portions of nutrients and detrital (organic debris) loads that drive the Bay-Delta foodweb.

Levee construction and bank protection have led to loss of wetland and shallow-water habitat. Dredging and disposal of dredge materials have contributed to the loss and degradation of important aquatic habitats.

Over the past several decades, accidental introduction of many marine and estuarine organisms from ballast waters of ships from the Far East has greatly, changed the planktonic and benthic invertebrate fauna of the Bay-Delta, with further ramifications higher in the foodweb.

List of Species to Benefit from Restoration Actions in the Delta-Suisun Marsh Planning Area

The Delta and Suisun Marsh support many species of native and nonnative fish, waterfowl, shorebirds, and wildlife. Below is a list of species associated with the Delta and Suisun Marsh.

Species	Sacramento-San Joaquin EMZ	Suisun Marsh EMU
Delta smelt	X	X
longfin smelt	X	X
green sturgeon	X	X
Sacramento splittail	X	X
Winter-run Chinook salmon	X	X
Spring-run Chinook salmon	X	X
Fall-run Chinook salmon	X	X
steelhead	X	X
Lange's metalmark butterfly	X	X

Valley elderberry longhorn beetle	X	X
Suisun ornate shrew		X
Suisun song sparrow		X
California clapper rail		X
California black rail	X	X
Swainson's hawk	X	X
salt marsh harvest mouse		X
Sacramento perch	X	X
riparian brush rabbit	X	
San Joaquin Valley woodrat	X	
greater sandhill crane	X	
California yellow warbler	X	X
least Bell's vireo	X	X
Western yellow billed cuckoo	X	
giant garter snake	X	X
Delta green ground beetle	X	X
saltmarsh common yellowthroat		X
California freshwater shrimp		X
hardhead	X	
Western least bittern	X	X
California red-legged frog	X	X
Western pond turtle	X	X
California tiger salamander	X	X
western spadefoot toad	X	
lamprey	X	X
white sturgeon	X	X

Ecological Vision for the Delta-Suisun Marsh Planning Area

Visions for the Sacramento-San Joaquin Delta EMZ are closely tied to those for Suisun Bay and Marsh EMU. They are related to visions for mainstem rivers and tributary watersheds. Flows and habitats in all of these areas are integrally linked. Many important anadromous fish and waterfowl species that use the Central Valley are affected by conditions in multiple EMZs. Improving Suisun Marsh health will help to achieve restoration goals set for the Sacramento-San Joaquin Delta EMZ. Likewise, improving conditions in the Delta will benefit the Bay.

Combined Vision for the Sacramento-San Joaquin Delta Ecological Management Zone and Suisun Bay and Marsh Ecological Management Unit

The vision for the Sacramento-San Joaquin Delta EMZ and Suisun Marsh EMU (Delta-Suisun Planning Area) is to achieve a healthier system that better provides for ecological needs of plants and animals using the system. A healthy ecosystem will have more natural freshwater flow and channel hydraulic patterns. A more natural channel configuration with greater amounts of slough and permanent and seasonal wetland habitats will provide more habitat for fish, waterfowl, and wildlife, and improve aquatic foodweb production and water quality. Improvements in riparian vegetation along waterways will reduce heating of the water and provide habitat for fish and wildlife. A healthy Delta-Suisun ecosystem will lead to improved survival of anadromous fish that depend on the Delta for a portion of their life cycles and the native resident fish community, including delta smelt and splittail, as well as resident wildlife and special-status plants.

A restored Delta-Suisun ecosystem will have improved ecological processes and habitats and reduced stressors. Ecological processes that will be improved include freshwater inflow and outflow, Delta hydraulics, channel configuration (dendritic), water temperature, floodplain processes, and aquatic and terrestrial foodweb productivity. There will be substantial increases in acreage of tidal emergent wetlands, seasonal and permanent nontidal wetlands, and shallow water, riparian, and tidal slough habitats. Stresses from land use, urban and industrial development, contaminants, land reclamation, water diversions, flood control (i.e., levees and bank protection), non-native plant and animal species, recreational activity (e.g., boating), water conveyance structures, livestock grazing, and agricultural practices will be reduced.

Following restoration, the Delta-Suisun Planning Area will have better fish spawning, rearing, and migration habitats. A healthy Delta-Suisun Marsh will be more effective in nutrient cycling and will have increased primary and secondary productivity. Productivity will increase through improved freshwater inflow and outflow, longer hydraulic residence time in Delta channels, and an increase in amount of tidal wetlands. Improved productivity will also improve productivity of northern San Francisco Bay.

Sacramento-San Joaquin Delta Ecological Management Zone

Much of the new fish and wildlife habitats in the Delta will come from agricultural lands. These lands will be purchased from willing sellers. Productive agricultural lands will continue to be an integral part of the Delta habitat mosaic and will be protected by upgrading channel configurations and levees. The Delta's levee system will be effectively maintained to reduce risk of failure. This will also minimize loss of high-value wildlife habitat and agricultural land. Riparian, wetland, and aquatic habitats along levees will be improved where possible. In those areas where leveed lands can eventually be restored to tidal action, exterior levees will be maintained until island interiors are restored to elevations necessary to support desired habitats.

A basic restoration strategy is to protect and enlarge areas of remaining native habitat and establish connectivity of these areas. Such areas in the Delta include:

- Cache Slough complex in the north Delta
- Stone Lakes in the north Delta
- Cosumnes River Preserve in the north Delta
- Sherman Island Wildlife Area in the western Delta
- Yolo Bypass in the north Delta
- New San Joaquin River bypass as part of a habitat corridor in the south Delta

Benefits to species and habitats will come predominantly through changes to important physical processes. These processes include:

- Freshwater flow into and through the Delta and Suisun Marsh
- Hydraulic conditions within Delta channels
- Restore the dendritic channel configuration of the Delta

Increasing amount of floodplain inundated by flood waters and tides, and increasing amount of shallow water and shorelines will increase tidal aquatic, wetland, and riparian habitats. Habitat improvements will be made in concert with floodplain and levee improvements. Levees will be rebuilt and maintained to include shallow water and riparian habitats that not only protect integrity of the levees, but also provide valuable fish and wildlife habitats. Agricultural lands on Delta islands will be managed to support waterfowl and wildlife better. Tidal sloughs and creeks will be restored to their former health from improved channel hydraulics, water quality, and riparian vegetation, and reductions in non-native aquatic plants (e.g., *Egeria*).

To ensure recovery, it will be necessary to reduce stressors. Examples of stressors include alteration of Delta hydraulic patterns by pumping in the South Delta, unscreened or poorly screened diversions, nonnative invasive plant species (e.g., *Egeria*), toxic substances, and human disturbance, such as erosion of sensitive habitats from boat wakes. In some cases, fish and wildlife may need temporary or even long-term support through artificial habitat construction, reductions in legal and illegal harvest, or artificial reproduction (e.g., hatcheries).

<u>North Delta EMU Vision.</u> Habitat restoration, fish passage improvement, and floodplain modifications are the primary focus of the restoration program in the North Delta Ecological Management Unit. Restoring a mosaic of tidal emergent wetland and SRA habitat at the ecological unit level should provide essential resources for all species, particularly communities or assemblages of species that have declined significantly within the Delta.

Habitat restoration will focus on five areas:

- Cache Slough Complex area, including shallow agricultural lands at the south end of the Yolo Bypass (i.e., Prospect, Little Holland, and Liberty islands)

- Tidal sloughs between the Sacramento Ship Channel and Sacramento River (i.e., Steamboat, Miner, Oxford, and Elk sloughs)
- Stone Lakes-Cosumnes Preserve Complex
- Main channel of the Sacramento River from Sacramento to Rio Vista
- Yolo Bypass in conjunction with improved floodplain processes

Seasonal patterns of freshwater inflow from the Sacramento River, Yolo basin (Cache and Putah creeks), and the Cosumnes and Mokelumne rivers would be improved. Fish passage problems in the Yolo Bypass, DCC, Sacramento Ship Channel, and Snodgrass Slough should be resolved. Unscreened diversions in important habitat and migration pathways should be screened. Non-native plants should be controlled.

The vision for the North Delta Ecological Management Unit focuses heavily on habitat restoration in the major subunits and the creation of a North Delta habitat corridor. In the Yolo Bypass, channels should be constructed to connect to channel improvements in the Yolo basin (i.e., connections with Putah and Cache creeks, Colusa drain, and Sacramento River through Sacramento and Fremont weirs). These channels should be constructed as permanent sloughs along either side of the bypass.

The sloughs will feed permanent tidal wetlands constructed along the bypass and connected with existing wetlands within the Yolo Basin Wildlife Area. The sloughs would provide rearing and migrating habitat for juvenile and adult salmon, and other native fishes. The sloughs would drain into extensive marsh-slough complexes developed in shallow islands (i.e., Liberty, Little Holland, and Prospect islands) at the lower end of the bypass. These changes, in conjunction with structural improvements to the bypass floodway (e.g., reducing the hydraulic impedance of the railroad causeway paralleling Interstate 80), and removing levees along the lower Sacramento Ship Channel (see below), will retain and possibly increase the flood bearing capacity of the Yolo Bypass.

To the east of the Yolo Bypass, the vision includes some improvements to the Sacramento Ship Channel. Fish passage problems at the gate structure on the Sacramento River at the north end of the ship channel should be resolved by constructing fish passage facilities. Connections between the ship channel and the new-island complexes at Liberty, Little Holland, and Prospect islands would be considered.

The major sloughs to the east between the ship channel and the Sacramento River, including Miner, Steamboat, Oxford, and Elk sloughs, should be improved as salmon migration corridors. Riparian habitat would be improved along these sloughs. Setback levees along portions of these sloughs may expand the slough and adjacent marsh complexes. Increases in hydraulic connections at the northern end of the slough complex on the Sacramento River and at the southern end at Prospect Island would increase tidal and net flows through the complex, which along with habitat improvements, could represent important rearing and migrating habitat improvements for salmon and other anadromous and resident fish.

Along the Sacramento River channel between Sacramento and Rio Vista, restoration is limited to improvements to riparian vegetation along major federal levees and to protection and possible improvements to retain remaining shallow-water habitat and tule berms along the river sides of levees. In addition, habitats would benefit from improving and maintain flows that contribute to riparian regeneration. These habitats may be important spawning habitat of delta smelt and other native Delta fishes and important rearing and migratory habitats of juvenile salmon and steelhead.

The vision for the Stone Lakes-Snodgrass Slough-Lower Cosumnes/Mokelumne complex at the northeast side of the North Delta EMU includes extensive habitat improvements. These improvements will be consistent with increasing connection of wetlands and riparian woodlands in Stone Lakes and Cosumnes preserves. Remnant marshes, riparian woodlands, and tidal sloughs along Snodgrass Slough would be protected and improved. Some small units of leveed agricultural lands would be converted to marsh-slough complexes. Flood control levees would be upgraded and riparian and shallow-water habitats improved on the waterside of the levees. Gated connections with appropriate fish passage facilities (and, potentially, screens) would be considered on the Sacramento River at the north end of Snodgrass Slough and Morrison Creek near Hood to provide this portion of the unit with water at a level consistent with pre-levee flows. Water hyacinth infestations would be controlled throughout the complex. All unscreened agricultural diversions located along salmon migratory corridors or spawning habitat of delta smelt would be screened. Modified operation of the DCC gates should be considered.

East Delta EMU Vision. The vision for the East Delta EMU focuses on restoration of native Delta habitats that will improve spawning, rearing, and migration habitats of native Delta fishes, as well as providing extensive new amounts of wetland, waterfowl, and wildlife habitat. Restoring a mosaic of habitat conditions at a landscape level should provide essential resources for all species, especially communities or assemblages of species that are rare within the Delta. Improvements along the south Mokelumne River and adjoining dead-end sloughs on the east edge of the Delta should be the focus of restoration efforts.

The vision for Georgiana Slough, Snodgrass Slough, Cosumnes River, and the South Ford of the Mokelumne River channel is to improve riparian and tidal marsh habitats and restore ecological processes, such as floodplain-river interactions, to the degree feasible to create a sustainable East Delta habitat corridor.

The vision for the east side of the unit along the South Mokelumne River and its adjoining dead-end sloughs (Beaver, Hog, and Sycamore sloughs) is extensive restoration of native Delta habitats. Levee setbacks and improvements along the river and sloughs would be accompanied by shallow-water and riparian habitat improvements.

Subsided leveed lands between the sloughs would be converted to floodplain overflow basins. These floodplains would support non-tidal, permanent tule marsh wetlands, or seasonal agricultural production. After many decades of flooding, marsh growth and sediment-laden flood overflow, these floodplains could be converted to tidal wetland.

Tidal headwaters of sloughs and adjacent lands would be opened to provide permanent tidal wetland marsh-slough complexes. Conversion of these agricultural lands would also reduce water diversions (i.e., loss of water and juvenile fish). Levee setbacks and a wider floodplain would improve habitat for fish including resident delta smelt and splittail, and seasonal migrant salmon and steelhead from the Cosumnes and Mokelumne rivers.

South Delta EMU Vision. Large-scale habitat restoration, channel and floodplain improvements, hydraulics, and losses at unscreened diversions and water export facilities are the primary focus of the restoration program in the South Delta Ecological Management Unit. Restoring a mosaic of habitat conditions at a landscape level and providing more-natural variability in aquatic conditions should provide essential resources for all species, particularly communities or assemblages of species that are rare within the Delta.

The vision for the South Delta EMU focuses on restoring floodplain habitat along the lower San Joaquin River between Mossdale and Stockton and improving riparian habitat along leveed sloughs throughout the unit. This is integral to creation of the San Joaquin River habitat corridor. Improving interior slough complexes of the Old and Middle rivers would depend on how water conveyance is conducted. Minimal improvements would be made under options that use existing Delta channels, because these channels would remain major conduits for moving water to the export pumps. Other options may provide more flexibility in improvements to riparian and emergent wetland habitat and channel configurations. The South Delta EMU could be a location in which extensive restoration of tidal emergent wetlands and tidal perennial aquatic habitats occurs. This is influenced by present land elevations because land subsidence has been less dramatic here that in other regions of the Delta.

A major focus of the vision in the south Delta will be expansion of the floodway in the lower San Joaquin River floodplain between Mossdale and Stockton. Setback levees and overflow basins offer opportunities to increase flood-bearing capacity of the existing configuration of river floodplain, as well as potential for creating significant amounts of native tidal emergent wetlands within the floodplain, regardless of how conveyance is conducted.

Another important focus of the vision is to solve problems with export of water from south Delta export facilities of the SWP and CVP near Byron and Tracy, respectively. It is imperative that loss of delta smelt and juvenile anadromous fish at the two export facilities be reduced as soon as possible. A new fish screen facility has been at the SWP export facilities, including state-of-the-art fish collection, handling, and transport system intended to reduce fish losses. However, fish losses resulting from fish entrainment and predation in the area of the facility are still a problem and require further remedial measures. Screen facilities have not yet been constructed at the CVP site and need further consideration. Additional measures could further reduce losses of fish from the south Delta by limiting diversions in seasons when fish are most abundant or vulnerable, and/or reconfiguring water conveyance routes. Fish losses could also be reduced by providing alternative sources of water to south Delta islands, which would otherwise divert water from existing channels.

A barrier at the head of Old River would be installed to prevent San Joaquin River water and fish from moving into the southern Delta. The barrier would help ensure that San Joaquin River water and juvenile salmon would have some chance of reaching the western Delta and the San Francisco Bay. Precautions would be taken in operation of the barrier to not cause increased movement of delta smelt, winter-run Chinook salmon, and other fishes south into the South Delta, and greater losses at south Delta export facilities.

<u>Central and West Delta EMU Vision.</u> Restoring habitat is the primary focus of the restoration program in the Central and West Delta Ecological Management Unit. Restoring a mosaic of tidal emergent wetland and SRA habitat on a large scale should provide essential resources for all species dependent on the Delta. Protecting and enhancing levees around all deeper islands should include major adjacent shoal and shallow-water habitats, as well as riparian and tule-berm (mid-channel islands) improvements. Changes in channel hydraulics will protect and improve habitats in specific sloughs.

Water conveyance through the Delta should be concentrated in specific channels that should be reinforced for that purpose, and little habitat restoration should be conducted along these channels so as not to encourage residence of juvenile fishes. Portions of deeper islands should be reclaimed where possible for tidal or nontidal marsh habitat. Unscreened diversions in important migration pathways of salmon and delta smelt should be screened or relocated to other channels.

The vision for the Central and West Delta Ecological Management Unit is to restore fresh emergent wetland habitat, shoal and shallow-water aquatic habitat, and adjacent riparian habitat. Along the main channel of the San Joaquin River, where levees are being upgraded, wetland, shoal, shallow-water, and adjacent riparian habitat should be improved. Where feasible, new construction should set back levees on portions of islands where the ratio of levee length to protected agricultural acreage is high. This will potentially reduce levee construction and maintenance costs and provide new tidal shallow water, slough, wetland, and riparian habitat.

These selected islands would be on higher elevation lands to minimize need for fill; however, some fill would be needed on deeper corners. This might be closely linked with the LTMS strategy for beneficial reuse of dredge materials, as it would accelerate marsh rebuilding processes. On such setbacks, levees would initially be maintained while fill was applied and habitats developed. Eventually, levees would be breached or gated to allow tidal flows into newly developed habitats. In some cases, entire small islands may be reclaimed, similar to the way in which portions of western Sherman Island in the west Delta were reclaimed for aquatic and marsh habitat. Along margins of the unit, selected levees could be breached or removed to provide areas of tidal wetlands and adjacent grasslands. The amount of new habitats potentially derived from these actions represents as much as 10 percent of total acreage in the Central and West Delta EMU.

Selected tidal channels and sloughs in the Central and West Delta EMU (e.g., Potato Slough and Disappointment Slough) retain good habitats in the form of midchannel islands, shoreline marshes and riparian woodlands, and shallow waters. These habitats would be protected and would also require active water hyacinth control.

On deeper Delta islands, levees should be upgraded to protect them from catastrophic failure. Portions of or all of some islands would be considered for establishing permanent nontidal wetlands. Approximately 30,000 acres of these islands would be appropriate for consideration of permanent or seasonal wetland development, or combination wildlife habitat and agricultural use. Selected islands may also be appropriate for flood overflow basins or seasonal water storage reservoirs.

Along the west side of the unit in the Highway 4 corridor, there are many opportunities to combine urban, agricultural, and native Delta habitat developments. There are many opportunities for tidal slough and marsh habitat development in this area.

Unscreened diversions along major pathways of salmon and delta smelt would be relocated or screened. Screening systems at Antioch electric power plants would be upgraded to reduce loss of fish to entrainment through or impingement on fish screens.

Suisun Bay and Marsh EMU Vision. The CALFED ERPP vision for the Suisun Bay and Marsh EMU is to restore tidal marsh and to restore and enhance managed marsh, riparian forest, grassland, and other habitats. This vision builds on a history of protective actions for the Suisun Marsh that initiated in the 1970s. In order to achieve this vision, the long-term future of Suisun Marsh levees and management of water quality with respect to both marsh management and Delta water supply are essential considerations. The need for an integrated approach and balance among ecological services desired by landowners and other marsh users led to formation of the Suisun Marsh Charter Group and initiation of the Suisun Marsh Planning effort. This is a Programmatic NEPA/CEQA process. Scoping processes have identified six goals:

- Goal 1. Ecological Processes – To rehabilitate natural processes wherever feasible in the marshes terrestrial, wetland and aquatic habitats, with minimal human intervention for native species and the communities upon which they depend.

- Goal 2. Habitats – Protect, restore, and enhance habitats where feasible for ecological and public values such as supporting species and biotic communities, ecological processes, recreation, scientific research, and aesthetics.

- Goal 3. Levees – Provide long-term protection of the area's resources by maintaining the integrity of the levee system.

- Goal 4. Non-native Invasive Species – Manage the area to prevent establishment of new non-native species, and reduce established non-native species populations.

- Goal 5. Water and Sediment Quality – Improve and/or maintain good water and sediment quality for beneficial uses, to support a healthy and diverse aquatic ecosystem, and to eliminate to the extent possible toxic impacts to people, fish and wildlife.

- Goal 6. Public Use and Waterfowl Hunting – Maintain heritage waterfowl hunting on the area and increase public awareness of the area's natural resources.

Efforts and opportunities to restore tidal action to selected managed wetlands and promote natural riparian and wetland succession in Suisun Marsh will be expanded. Shallow-water, wetland, and riparian habitats within the marsh and along the shorelines of the Bay will be protected and improved, where possible. Upland habitats adjacent to riparian and wetland habitats will also be protected and improved. Efforts will focus on increasing acreage open to tidal flows (e.g., by removing or opening levees) and providing connectivity among habitat areas to aid in the recovery of species, such as the salt marsh harvest mouse, clapper rail, and black rail. Those habitat areas will provide essential shelter during high tides. Providing natural habitat transitions between wetland habitats and adjacent upland habitats would provide habitat required by many special status plant species, protect wetland habitats from disturbance, and provide area for the natural relocation of tidal wetlands with future sea-level rise.

Diverting water from Suisun Marsh channels for managed nontidal wetlands and controlling salinity of water entering the marsh through Montezuma Slough will continue, but with consideration for maintaining the natural hydrologic regime and salinity levels of the slough and marsh. Water quality standards specified in the 1995 Water Quality Control Plan will be re-evaluated as restoration targets for the eastern marsh and at several locations in the central marsh. Flows into the northwestern marsh will be improved.

Suisun Marsh and Suisun Bay will function as high quality spawning and rearing habitat and an effective fish migration corridor. Improving marsh and slough habitats will benefit Chinook salmon, striped bass, Delta smelt, splittail, and other estuarine resident fish in the marsh and Suisun Bay. A healthy Suisun Marsh-Bay ecosystem will be an important link in the estuary foodweb by improving primary and secondary productivity. Marsh and Bay productivity will improve as freshwater inflow events increase in dry and normal years and acreage of tidal wetlands and associated tidal perennial aquatic habitat increases.

Water diversions from Suisun Bay for cooling at the Pittsburg power plant will be conducted with minimal adverse effects on eggs, larvae, and juvenile fish. New fish screening technology or alternative sources of cooling water (such as cooling towers) should be considered.

Effort will be made expand restoration in the northeastern portion of Suisun Marsh and restore connectivity with areas such as the Jepson Prairie Preserve in the Yolo Basin Ecological Management Zone.

Other focal points are reducing stressors, such as non-native marine invertebrates in ship ballast water and contaminants in municipal, industrial, and agricultural discharges (such as selenium from oil refinery operations) into the Bay.

Goals and Objectives for the Delta-Suisun Marsh Planning Area

For the Delta and Suisun Marsh, emphasis is placed on an ecosystem approach and ERP Goals 1, 2, and 4 focused on species recovery, natural processes rehabilitation, and habitat restoration/protection, respectively. The ERP chose to emphasize these goals because they represent current ecological priorities, and because they comprise a range of objectives that can be most readily addressed with restoration actions. These objectives are based on the driving forces of recovery, which are habitat and natural physical processes. Other goals (3, 5, and 6) and associated objectives, while important, are less directly related to recovering at-risk species or are more difficult to control or improve. The following ERP goals and objectives are applicable for the Delta-Suisun Marsh planning area and, in effect, prioritize restoration actions needed at the present time. The following goals and objectives for the Delta-Suisun Marsh Planning Area reflect those from the Strategic Plan, paraphrased for brevity and focus on the Delta-Suisun Marsh planning area:

- Goal 1. Achieve recovery of at-risk native species in the Delta and Suisun Marsh.
    - Objective 1: Achieve, first, recovery and then large self-sustaining populations of at-risk native species dependent on the Delta, Suisun Bay and Suisun Marsh; with emphasis on Central Valley winter-, spring-, and fall/late fall-run Chinook salmon ESUs; Central Valley steelhead ESU; delta smelt; longfin smelt; Sacramento splittail; and green sturgeon. Several species of arthropods, reptiles, birds, mammals, and plants in the Delta-Suisun Marsh ecosystem also are important for recovery efforts.
    - Objective 2: Contribute to the recovery of at-risk native species, including Sacramento perch and several species of arthropods, reptiles, birds, mammals, and plants.
    - Objective 3: Enhance and/or conserve native biotic assemblages and communities, including native resident estuarine, anadromous, and freshwater fish assemblages; neotropical migratory birds; wading birds; shore birds; waterfowl; anuran amphibians; estuarine plankton assemblages, estuarine and freshwater marsh plant communities, riparian plant communities, seasonal wetland plant communities, vernal pool communities, aquatic plant communities, and terrestrial biotic assemblages associated with aquatic and wetland habitats.
    - Objective 4: Maintain the abundance and distribution of several species of arthropods, reptiles, birds, mammals, and plants.

- Goal 2. Rehabilitate natural processes in the Delta and Suisun Marsh, with minimal human intervention, to support natural aquatic and associated terrestrial biotic communities and habitats, to favor native species of those communities.
    - Objective 1: Establish and maintain hydrologic and hydrodynamic regimes that support the recovery and restoration of native species and biotic communities, and support the restoration and maintenance of functional natural habitats.
    - Objective 2: Increase estuarine productivity and rehabilitate estuarine food web processes to support the recovery and restoration of native estuarine species and biotic communities.
    - Objective 3: Rehabilitate natural processes to create and maintain complex channel morphology, and in-channel islands.
    - Objective 4: Create and/or maintain flow and temperature regimes that support the recovery and restoration of native aquatic species.
    - Objective 5: Establish hydrologic regimes in streams, including sufficient flow timing, magnitude, duration, and high flow frequency, to maintain channel and sediment conditions supporting the recovery and restoration of native aquatic and riparian species and biotic communities.
    - Objective 6: Reestablish floodplain inundation and channel-floodplain connectivity of sufficient frequency, timing, duration, and magnitude to support

the restoration and maintenance of functional natural floodplain, riparian, and riverine habitats.

- Goal 4. Protect and restore functional habitat types for ecological values.
  - Objective 1: Restore large expanses of all major habitat types, and sufficient connectivity among habitats to support recovery and restoration of native species and biotic communities and rehabilitation of ecological processes. Habitat types include tidal marsh (fresh, brackish, and saline), tidal perennial aquatic (including shallow water and tide flats), nontidal perennial aquatic, tidal sloughs, mid-channel island and shoal, seasonal wetlands, riparian and shaded riverine aquatic, inland dune scrub, upland scrub, and perennial grasslands.
  - Objective 2: (not applicable for Delta-Suisun Marsh Planning Area).
  - Objective 3: Protect tracts of existing high quality major aquatic, wetland, and riparian habitat types, and sufficient connectivity among habitats to support recovery and restoration of native species and biotic communities and rehabilitation of ecological processes.
  - Objective 4: Minimize the conversion of agricultural land to urban and suburban uses and maintain open space buffers in areas adjacent to existing and future restored aquatic, riparian, and wetland habitats, and manage agricultural lands in ways that are favorable to the Delta-Suisun Marsh ecosystem.
  - Objective 5: Manage the Yolo Bypass as major areas of seasonal shallow water habitat to enhance native fish and wildlife.

Rationale for Goals and Objectives

Goal 1 places highest priority on recovering at-risk native fishes that are greatly affected by and, in turn, strongly affect operation of the State Water Project (SWP) and Central Valley Project (CVP). Progress has been made improving condition of anadromous salmonid populations north of the Delta, but significant declines for some aquatic species within the Delta have been observed (POD species). For the Delta-Suisun Marsh Planning Area, this objective addresses the need to focus on at-risk species dependent on the Delta, Suisun Bay and Suisun Marsh. Goal 1 also addresses benefits to other at-risk native species in the Delta-Suisun Marsh Planning Area.

Goal 2, Objective 1 emphasizes the fact that most, if not all, native species and habitats of the Delta–Suisun Marsh Planning Area depend on dynamic hydrologic and hydrodynamic regimes (e.g. freshwater inflow, salinity, and Delta water circulation) that approximate the historic regimes. This includes reconnection of adjacent watersheds to the Delta, establishment of connectivity within the watershed, maintenance or enhancement of Delta inflow and outflow. These processes are of particular concern regarding assessment of present through-Delta water conveyance and considerations of alternative conveyance options. Specific issues to be studied include restoration of natural salinity gradients, adequacy of inflow from the San Joaquin River, residence time, desirable patterns of flow relative to water year type, and causes of pelagic species declines. Moreover, potential for improved environmental water quality and quantity has not been fully realized.

Goal 2, Objective 2 for increasing estuarine productivity is closely tied to Goal 2, Objective 1 and subsequent habitat related objectives. Productivity in the estuary is complex and poorly understood, but is influenced by amount of shallow water habitat, which has been significantly reduced from historic levels and has been compromised by introduction of invasive clams. Presence of non-native species and lack of biological understanding may affect implementation of this objective.

Goal 2, Objective 3 addresses the complex channel morphology comprising extensive intertidal habitats formed by geomorphic processes. These habitats require proper elevation and sediment or organic soil formation. This objective relies on restoration of large expanses of tidal emergent wetland in the Delta and Suisun Marsh in areas with appropriate elevation connected to adjacent upland areas.

Goal 2, Objectives 4, 5, and 6 emphasize the importance of maintaining and/or improving hydrology and temperature regimes in rivers and streams, and inundation of floodplain habitat, in order to support recovery of native aquatic and riparian species and biotic communities. Restoring large expanses of riparian and floodplains would require establishment of channel-floodplain connectivity.

Goal 4 considers the fact that all major natural habitat types in the Delta-Suisun Marsh Planning Area have been reduced to a small fraction of their historic area resulting in a large number of at-risk species that depend on them. Restoring the integrity and connectivity of these habitats is needed to support recovery and restoration of native species, biotic communities, and ecological processes.

Current Information for the Delta/Suisun Marsh Planning Area

Because CALFED planning efforts, including the ERP and its related planning documents, were initially completed in 2000, it is necessary to look to more recent information for planning the Stage 2 Conservation Strategy for the ERP. Recent information related to the Delta-Suisun Planning Area that can supplement pre-existing information include the following:

Public Policy Institute of California Report

Public Policy Institute of California and a team of experts from the University of California, Davis, decided to explain the vulnerability of the Sacramento–San Joaquin Delta and to lay out a series of options for addressing current and likely future problems. This report, *Envisioning Futures for the Sacramento–San Joaquin Delta*, describes why the Delta matters to Californians and why the region is currently in a state of crisis, from threatened freshwater supplies for the whole State, to potential extinction of numerous fish species. The report concludes with recommendations for several actions, some related to the use of technical and scientific knowledge, and others to design of governance and finance policies.

Pelagic Organism Decline

Abundance indices calculated by the Interagency Ecological Program (IEP) through 2005 suggest recent marked declines in numerous pelagic fishes in the upper San Francisco Estuary (the Delta and Suisun Bay). Although several species show evidence of long-term declines, recent low levels were unexpected given the relatively moderate winter-spring flows of the past several years.

In response to these changes, the IEP formed a Pelagic Organism Decline (POD) work team to evaluate the potential causes. The product of this effort was a 2005 study to provide insight into the best lines of inquiry for 2006-2007 studies. The major findings through 2005 were synthesized using two conceptual modeling approaches. First, the work team developed species matrix models and used these models to examine which stressors (entrainment, toxic effects on fish, toxic effects on fish food items, harmful algal blooms, clam *Corbula* effects on food availability, and disease and parasites) were most likely to be important. Importance was used to mean either stressors supported by available data or stressors which could not be ruled out based on available data. Secondly, the work team constructed narrative explanations for the recent step decline in abundance of pelagic species in the context of their long term trends or previous patterns. Narratives have been developed for the major components: 1) *previous abundance levels*, which describes how continued low abundance of adults leads to juvenile production; 2) *habitat*, which describes how water quality variables (including contaminants and toxic algal blooms) affect estuarine species; 3) *top-down effects*, which posits that predation and water project entrainment affect mortality rates; and 4) *bottom-up effects*, which focuses on food web interactions in Suisun Bay and the west Delta.

The IEP work team produced a 2005 work plan, which provided an overview of the problem, a conceptual model, and description of a "screening level" study to examine some of the suspected major causal factors. Highlights of the 2005 results included the following initial results:

- <u>Pelagic fishes.</u> 1) In 2005, the highest spring outflow conditions since 2000 failed to improve fish abundance; 2) there was no evidence of a recent decrease in the amount of "physical habitat" for delta smelt or juvenile striped bass; 3) there was no evidence of a recent major decline in apparent growth rates for delta smelt, longfin smelt, or striped bass; 4) in 1999 and 2004, delta smelt in Cache Slough had higher residual growth/condition than other locations; 5) striped bass age-fecundity relationships in 2005 did not differ substantially from relationships developed in the 1970s and 1980s; and 6) otolith analyses indicated that in 1999 delta smelt spawned throughout the upper estuary recruited to the adult population, whereas in 2004, only fish spawned in the Delta recruited.

- <u>Food web/exotic species.</u> 1) Reanalysis of the zooplankton data revealed that there was no recent step-change in calanoid copepods, but we are still determining whether regional (e.g., Suisun Bay) declines occurred; 2) there has been no recent major decline in chlorophyll *a* (an index of phytoplankton biomass, but we are still determining whether regional Suisun Bay declines occurred; 3) the toxic blue-green alga *Microcystis* was present throughout the Delta at substantially higher levels in summer 2005 than in summer 2004; 4) although there has been a recent expansion in the range of the clam *Corbula*, recent occurrence is comparable to the 1987- 1992 drought; and 5) changes in sediment composition and benthic assemblages occurred estuary-wide in 1999-2000.

- <u>Toxics.</u> 1) Studies on contaminants found that there have been changes in the patterns of use for herbicides and pyrethroid pesticides, but it is plausible, but unclear if these changes pose serious risks for aquatic species; 2) significant acute or chronic toxicity to the amphipod, *Hyalella azteca*, was detected at four out of ten sampling sites, but the cause(s) was not identified; 3) no significant toxicity to the cladoceran, *Ceriodaphnia dubia*, the delta smelt or the juvenile striped bass was observed during the study period; 4) delta smelt are more sensitive to copper than previously reported and are 10-12 times more sensitive than juvenile striped bass; and 5) delta smelt from 2003 and 2005 (limited) showed more liver lesions at two locations representing general regions in Suisun Marsh (near and in Nurse Slough) and the Sacramento River at Cache Slough and the Sacramento Deepwater Ship Channel.

- Water Project Operations. 1) There have been changes in the input flows to the Delta in recent years, including a slight increase in average Sacramento River flow since 2001 and a substantial reduction in peak San Joaquin flows since 1999; 2) there was no evidence of a recent major change in residence time, consistent with the lack of change in chlorophyll; 3) increases in the pattern of wintertime salvage are consistent with hydrodynamic changes occurring each winter since 2001; 4) non-consumptive water use by Contra Costa and Pittsburg power plants may reach 3200 cfs (both facilities combined). The fish population impacts of these diversions have not been evaluated since the early 1980s, but given their location and the potentially large cooling water flux through them, the impacts could be substantial.

Suisun Marsh Implementation Charter
The Suisun Marsh Implementation Charter (Charter) resulted from a 1998 effort by CALFED to collect cost/benefit information for including Suisun Marsh levees, followed in 2000 by the FWS draft jeopardy biological opinion stating that the Suisun Marsh Protection Act (SMPA) Plan, including evaluated levees, would impact endangered species in the Marsh. The purpose of the Charter is to develop a regional plan to integrate CALFED objectives (Water Quality, Water Supply Reliability, Delta Levee Stability, and Ecosystem Restoration), SMPA Plan, and other management and restoration goals for the Marsh, in a manner that addresses endangered species needs and current science, is responsive to the concerns of stakeholders, and is based upon voluntary participation by private land owners. Charter agencies include:

- U.S. Bureau of Reclamation (USBR)*
- U.S. Fish & Wildlife Service (USFWS)*
- California Department of Fish and Game (DFG)*
- Suisun Resource Conservation District (SRCD)*
- California Department of Water Resources (DWR)*
- U.S. Army Corps of Engineers (USACE)
- National Marine Fisheries Service (NMFS)*
- San Francisco Bay-Delta Science Consortium (Bay-Delta Consortium)
- California Bay-Delta Authority (CBDA)/CALFED Bay-Delta Program*
- CBDA Ecosystem Restoration, Levees, Drinking Water, and Science Programs
- Bay Conservation and Development Commission (BCDC)
- US Geological Survey (USGS)
- Suisun Resource Conservation District (SRCD)
  *Denotes Charter Principal Agency

Objectives of the Charter include:

- Prepare an Implementation Plan (Plan) to guide ongoing operations in managed wetlands and recovery actions for listed species in the Marsh. The Plan has the following intentions:
    - Allow participating Agencies (NMFS, USACE, USBR, USFWS, DFG, DWR, and SRCD) to identify and resolve issues, such as those related to the USACE Regional General Permit and the Suisun Marsh Preservation Agreement and their associated biological opinions, as well as remaining issues with past biological opinions.
- Improve coordination and collaboration among agencies on management decisions and activities within the Marsh.
- Ensure that the Plan is consistent with CALFED, which includes the Ecosystem Restoration Program, Levee Program, Drinking Water Quality Program, Multi-Species Conservation Strategy, Milestones, and Science Program, and is implemented in an adaptive management framework.
- Ensure that the Plan is consistent with the Suisun Marsh Preservation Act.
- Ensure that the Plan is consistent with the recovery needs of threatened and endangered species.
- Balance the habitat needs of species in managed wetlands with the habitat needs of tidal marsh-dependent species.
- Consider developing and submitting recommendations for water quality standards in Suisun Marsh to the State Water Resources Control Board. Recommendations should be consistent with the CALFED program, the recovery needs of threatened and endangered species, and the protection of managed wetlands. All appropriate information, including the recommendations of the Suisun Ecological Workgroup, should be used.

In 2001, CALFED approved the Charter, and the Suisun Marsh Implementation Plan began receiving funds for development, pilot studies, land acquisition, environmental review, scientific input and permitting. The Charter Principal Agencies meet monthly to guide development of the Habitat Management, Preservation, and Restoration Plan for the Suisun Marsh (Suisun Marsh Plan) and its accompanying Programmatic Environmental Impact Statement/ Environmental Impact Report (PEIS/EIR).

ERP Conservation Strategy Map and Covered Habitats for the Delta-Suisun Marsh Planning Area

Given recent events of litigation and water operations, the focus on the Delta for improving conditions for Delta smelt and other pelagic organisms has become paramount. While the ERP continues to develop the Delta Restoration Plan and its Conservation Strategy for the entire CALFED Solution Area, it became apparent that a graphical component that illustrated a biological vision for the future of the Delta was needed. Although this draft vision is habitat based, we believe it would improve the condition of the aquatic system that benefits Delta smelt and other native Delta dependent species.

The ERP agencies recognize the importance of finding solutions to reverse the decline of Delta smelt, but remain committed to broader restoration planning and conservation efforts for multiple species. In looking at the historical conditions of the Delta, we drafted a graphical representation that identifies restoration opportunities within the Delta-Suisun Planning Area based upon existing elevations and habitat and natural process requirements of pelagic organisms and other native fishes (Appendix C). For purposes of this initial draft of the strategy, we have identified five broad land categories for restoration. We have shifted away from the focus on shallow water habitat in the original ERP documents to intertidal habitat which will allow the reestablishment of food web support and the types of habitat which were most abundant in the historic Delta. These categories include inter-tidal, channel, floodplain, grassland/vernal pool transition corridor, upland transition, and managed wetland and wildlife friendly agriculture.

This is a biological view of how the Delta could be configured to restore historic form and function to the maximum extent. The main thrust of the strategy at this juncture is to present a GIS-based overview of the Delta-Suisun Marsh Planning Area, showing areas with potential for various kinds of habitat restoration. Elevation and soil type are the drivers for this preliminary depiction that does not include water conveyance options infrastructure, or land use patterns. The first step in developing the map for the conservation strategy directly addresses habitat restoration. In subsequent versions ecosystem processes, such as hydrodynamics, temperature, salinity, residence times, etc., will be addressed. In addition, the strategy will eventually address species recovery and how the restoration of habitat and ecosystem processes will benefit individual species. Detail on restoration actions that address flow and river operations, which are the primary drivers of aquatic systems and habitats, will be incorporated in future phases once the Delta Restoration Plan conceptual models (summer, 2007) and the anadromous fish recovery plans (summer, 2008) are completed. A key element of the models is the identification of critical limiting factors, as well as and linkages with other components of the system.

After incorporating an elevation map of the delta (from the DWR Status and Trends Report; data from 2002), rough contour lines were drawn to identify potential restoration opportunity areas. Ecological rationale for mapping decisions was driven by historical conditions and elevations to accommodate sea-level rise and climate change. Map elevations were presented in 5-foot increments. One major assumption was that -5 to 0 feet and 0 to 5 feet elevations may have opportunities for tidal marsh. Land above 5 feet was considered to be upland/transition habitat. Land below -5 feet was considered deeply subsided and not conducive to restoration of habitat for native species.

In identifying restoration opportunity areas, we started with consideration of pelagic organism needs and constraints for improving conditions for them. Looking at the existing elevations and conditions in the Delta, it is clear that the central or deep Delta is not very compatible with restoration of habitats and processes that increase habitat area and food productivity for pelagic organisms. Considering the Delta Risk Management Strategy and levee sustainability, the likelihood of sustainable restoration of the deep Delta for these purposes is limited. Thus, we have identified the deep Delta as an area we refer to as Managed Wetland and Wildlife Friendly Agriculture.

For the purposes of this draft of the strategy and the initial focus on pelagic organisms, the Managed Wetland and Wildlife Friendly Agriculture category is intended to highlight the fact that restoration actions in the deep Delta are extremely limited or non existent in a sustainable manner that benefit critically endangered native fish species. Given existing elevations and current understanding of ecology of flooded islands like Frank's Tract, benefits to pelagic organisms and other species would not be achieved. The focus from a habitat perspective in these areas should be actions to counter subsidence and benefit wildlife and/or encourage agricultural practices that do not contribute to continued subsidence and benefit wildlife, particularly waterfowl and sandhill cranes.

The strategy recognizes the value of some existing land use practices in this area of the Delta for many other species, the sustainability of these lands are in question based on interior land elevations and the threat to levee integrity from seismic events, sea level rise, and global warming; therefore, the ERP does not anticipate funding projects in this region of the Delta. Methods that minimize or reverse subsidence have shown promise, and so the focus should be shifted to large scale implementation of such programs. There have been several studies done on Twitchell Island that have examined processes and rates of accretion and, based on those findings, large scale implementation on whole-island scales should be pursued.

Implementation of large scale, whole island approaches to reverse subsidence would be beneficial for multiple purposes. While opportunities for contributions to aquatic species are limited under existing conditions, programs that offer incentives for 10- or 20-year studies for subsidence reversal on large tracts of land could help improve sustainability of Delta levees and reduce the level of risk of catastrophic failure. This would improve long term sustainability of the Delta and allow future restoration of additional native fish habitat areas. These efforts should be focused on raising elevations on the interior of the islands as rapidly as possible, rather than on optimizing habitat for multiple species.

With regard to island levee habitats, there have been significant expenditures on alternative levee designs and planning by ERP and other CALFED programs. The ERP will consider re-evaluation of levee habitat recommendations in this region for habitat value and sustainability reasons. This is not to say that habitat requirements would no longer exist, but that maybe evaluations should be made to focus riparian restoration and conservation in areas of the Delta where natural processes and conditions support it, where it provides the greatest functional value, and where riparian might have been historically present. This approach might assist in streamlining the permit process for levee improvements in consideration for island management methods that promote accretion in some regions of the Delta.

The category of intertidal is focused on areas of the Delta suitable for tidal perennial aquatic, Delta sloughs, mid channel islands and shoals, saline and fresh emergent wetland, riparian and riverine aquatic, seasonal wetlands, and inland dune scrub habitats. Properly functioning estuarine systems have deep open water channels connected to shallower channels that are imbedded in and supported by marsh plains. This part of the system, which we are referring to as intertidal, offers the opportunity to restore diverse plant communities that can contribute to the overall productivity of the Delta. These habitats once totaled approximately 400,000 acres, and today consist of only a few thousand acres. These diverse communities provide structure and processes that benefit both aquatic and terrestrial sensitive species. While species such as Delta smelt may not be limited by food sources, production from tidal habitats that is hydraulically connected to the channels of the Delta could improve conditions for pelagic organisms.

The areas identified as floodplains are also highly productive habitats with a direct linkage to aquatic species. Restoration opportunities for riparian and riverine aquatic, fresh emergent wetland, seasonal wetland, nontidal and tidal perennial aquatic, and perennial grassland habitats are the focus. There has been extensive research on the Yolo Bypass and Cosumnes River that indicate that native and migratory fish respond well when they have access to floodplain habitats. For example, those studies suggest that juvenile salmon on the floodplain have better body conditioning and survival rates. Splittail is another species that benefits from floodplain for spawning. While duration and timing of flooding plays an important role in the value and benefits of floodplain for aquatic species, we are not going into any detail on flow requirements at this time.

The strategy assumes that new floodplains would be shaped and developed based upon availability of flows or changes in river or export operations that might influence/contribute to restoration. In those areas where old flood structures such as Paradise Cut along the San Joaquin River exist, restoration and enhancement opportunities should take into consideration the flow and duration needs of species. It is fair to recognize that a new paradigm is needed for how floodplain and, more importantly, flood control is considered. The historic view has been to construct and design channels that transport water quickly away rather than providing over flow areas where flows can spread out over terrestrial dominated landscapes. Evidence on the Cosumnes River indicates that dynamic processes are needed to support complex riparian habitats and upland systems. The energy and forces from the seasonal events are critical processes that shape sediment accretion, suspension, and ultimately the floodplain habitats.

The area identified as upland transition is best characterized as land well above sea level (>5 feet). Habitats compatible with this category include annual and perennial grassland, riparian and riverine aquatic, seasonal wetland, vernal pools, and inland dune scrub. This category highlights the importance of maintaining diverse assemblages of habitats, both spatially and elevationally, and allowing the system to respond to drivers of change, such as sea level rise. This diversity at the system level enables the environment to respond to change and sustain itself. With the growing evidence of future sea level rise and global warming, the Delta environment and species are going to require space to respond to change. Tidal areas might be displaced in the future with higher waters so providing space that accommodates change and allows for natural succession is critical.

Specific areas of opportunity are identified on the map considering current knowledge. Stewart Tract and the eastern portion of Fabian Tract were designated as bypass floodway. The western portion of Fabian Tract is considered to be suitable for tidal marsh, which is consistent with our designation based solely on elevation. Based on elevation, large portions of Fabian Tract, Union Island, Drexler Tract, and Middle Roberts Island appear to have opportunities for tidal marsh restoration, and lands to the south would be appropriate for upland/transition habitat. The narrow strip of land along the eastern edge of the delta may have potential for tidal marsh restoration (West of I-5 and north of Stockton to McCormack Williamson Tract). Urban development around the City of Stockton limits the availability of land for upland/transition habitat north to about Bear Creek. North of Bear Creek there is higher elevation with potential for upland/transition habitat. The future of Staten Island may be dictated in part by current management plans. McCormack-Williamson Tract is 0 to +5 feet in elevation, and was designated as tidal marsh. Deadhorse Island could be tidal marsh but elevation is subsided and 2 to 4 feet of accretion would be necessary. The islands along the Sacramento River contain areas of inorganic, mineral soils and orchards (primarily pear), which correspond to historic natural levees which supported riparian and upland habitats. The northern Yolo bypass was designated as managed bypass with reference to the Yolo Bypass 5-Step plan (Putah Creek, Lisbon Weir, Additional multi-species habitat development, Tule canal connectivity, and Multi-species fish passage). Portions of the Yolo area are outside the legal Delta.

The ERP implementing agencies will be continuing to refine the Conservation Strategy over the next 6 to 12 months based on ongoing research, new information from other studies (Delta Risk Management Strategy, Suisun Marsh Implementation Plan, ERP End of Stage 1 review, and species recovery plans) and technical and public input. Elevation mapping sourced from LiDAR images (a satellite imaging technology) will refine initial designations. A soil layer will be used to help further refine potential vegetation types. In order to address ecological processes (including resulting effects on temperature, salinity, etc.), conveyance options and hydrodynamics will be included. Installation of in-Delta barriers to remove connections between rivers (cross-channels) for a more dendritic drainage system, and levee setback to achieve shallow water habitat and flow heterogeneity will be considered in future versions. Plans will be determined for subsided islands and areas proposed for restoration will be prioritized.

Relationship of Delta-Suisun Marsh Map categories to Ecosystem Restoration Program Plan habitat categories.

	Managed Wetland and Wildlife Friendly Ag	**Inter-tidal**	**Floodplain**	**Upland Transition**	**Grassland/ Vernal Pool Transition Corridor**	**Channel Islands**	**Water**
Tidal Perennial Aquatic Habitat		X	X				
Nontidal Perennial Aquatic Habitat			X	X			
Delta Sloughs (dead-end)		X					
Delta Sloughs (open-ended)		X					
Mid-channel Islands and Shoals		X				X	
Saline Emergent wetland		X					

Fresh Emergent Wetland		X	X				
Seasonal Wetlands	X		X	X	X		
Riparian and Shaded Riverine Aquatic Habitats			X	X	X		
Riparian and Riverine Aquatic Habitats (scrub, woodland, forest)		X	X	X	X		
Freshwater Fish Habitats		X	X				X
Essential Fish Habitats		X	X				X
Inland Dune Scrub Habitat				X	X		
Perennial Grassland			X	X	X		
Agriculture Lands (wetlands)	X						
Agriculture Lands (uplands)	X						

Delta Regional Ecosystem Restoration Implementation Plan

As ERP implementation progressed, it became apparent that the level of detail within each of four CALFED regions could be substantially refined as projects were implemented. The Sacramento-San Joaquin Delta region was chosen to develop a demonstration plan for melding project evaluation, future project selection, future management decisions, and adaptive management into updated regional visions presented in ERPP Volumes 1 and 2. The resulting plan was titled the Delta Regional Ecological Restoration Implementation Plan (DRERIP), begun in 200_ and slated for completion by 200_. The purpose of the regional implementation plan approach is to clearly articulate an integrated planning, implementation, and scientific framework, with which to implement and evaluate restoration of the Bay-Delta ecosystem. Following the DRERIP, the ERP intends to develop regional implementation plans for the remaining regions (Suisun Marsh and North San Francisco Bay, Sacramento River Basin, and San Joaquin River Basin).

Science Standard

Like all CALFED programs, the ERP holds itself to a high standard of scientific integrity for development, review, and implementation of program activities. By integrating world-class science and peer review into every aspect of its program, the ERP is developing the best scientific information possible to guide decisions and evaluate actions that are critical to its success and effectual and prudent management of the Bay-Delta watershed by the responsible agencies. To ensure scientific integrity of developing, reviewing, and implementing its conservation strategy for Stage 2 of CALFED, the ERP is relying primarily on the CALFED Independent Science Board (ISB), CALFED Science Program, and the DRERIP Adaptive Management Planning Team (AMPT).

The AMPT, in particular, is being relied upon to help guide ERP planning for the Delta EMZ. Conceptual Models for Delta ecological processes, habitats, stressors, and species are being developed and several are nearing completion. These models will to be used to evaluate restoration actions identified in the ERPP and develop potential updated actions. Essentially, the conceptual models present information for ascertaining whether an action will have its intended effect, and what the potential is for unintended effects (risks).

This work is being conducted through a stringent process involving modeling workshops and peer review. Completed conceptual models will be used in a vetting process to evaluate and clarify potential restoration actions in light of current scientific knowledge to help the ERP make informed decisions about Delta restoration options. The ERP agencies have determined that the AMPT process represents the acceptable scientific standard for ERP purposes, as well as the standard by which they would judge proposed activities by other entities affecting species and habitats under their purview.

Monitoring, Adaptive Management, and Performance Measures

Because there is incomplete knowledge of system functions and effects of individual actions on populations and processes, and because the CALFED agencies must be responsible for identifying and tracking effects of their actions, the CALFED Bay/Delta Program includes the concept of adaptive management. Monitoring key system attributes (or indicators), completing focused research to obtain better understanding, and phasing implementation based on information gained are all central to the adaptive management process. Indicators and performance measures are used to translate program goals and objectives into measurable benchmarks of program success. The ERP, Science Program, and Comprehensive Monitoring, Assessment, and Research Program (CMARP) have worked on ecosystem indicators and performance measures over the past 10 years, but it is recognized that a more comprehensive, robust, and accessible set of indicators and performance measures is needed.

Restoring and managing the Bay-Delta ecosystem requires a flexible framework that can generate, incorporate, and respond to new information and changing conditions. Adaptive management provides such flexibility and opportunities for enhancing our understanding of the ecosystem. The process identified in the Strategic Plan (CALFED 2000) provides an appropriate framework for monitoring and adaptive management, which should help define action modifications to improve performance of restoration activities. The process includes numerous assessments and feedback loops so that management decisions are based on the best and most current information.

The CALFED approach to adaptive management begins with defining a management problem and clear goals and objectives, assessing system dynamics with conceptual models (and possibly simulation models) to derive anticipated responses to management options and address uncertainty. A model of system dynamics is always implicit in any statement that a restoration action will have certain consequences (Healey 2001). In adaptive management it is critical to identify these implicit models and their consequences and quantitatively examine any contradictions in the process of planning for restoration. Conceptual and simulation models of system behavior provide the basis for choosing among restoration alternatives and designing the monitoring program (Healey 2001).

Based on modeling results, specific management options are designed and implemented in ways that allow system responses to be detected. Monitoring is subsequently conducted based on the hypothesized system dynamics, and results are used to reassess the management options implemented. Results are fed back into the management options development process to revise the options, as necessary (Figure 1). The ERP agencies have highlighted the requirement for comprehensive aquatic and terrestrial monitoring as part of the Multi-species Conservation Strategy (MSCS) and program-level approvals for implementing the CALFED Bay-Delta Program under FESA and the NCCPA.

Adaptive management incorporates scientific problem solving (experimentation) into management actions in a way that develops better resource management systems (Healey 2001; Walters 1986). The five steps of experimental protocol for adaptive management identified by CALFED (2000) are:

1. Model the system in terms of current understanding and speculation about system dynamics.
2. Design the management intervention to maximize benefits in terms of both conservation and information.
3. Implement management and monitor system response.
4. Update probabilities of alternative hypotheses.
5. Design new interventions based on improved understanding.

For each objective of the ERP, adaptive management would follow a stepwise process including development of testable hypotheses, which would help determine whether an objective is being met. Conceptual model(s) that underlie the implementation measures would provide for a structured analysis of the expected effects of the implementation measures (CALFED 2000). The models would link the implementation measures to the resource objectives through a set of logical cause/effect relationships. The hypotheses would connect the actual implementation measures with expected outcomes. The conceptual models should provide a means to identify critical biological uncertainties, where monitoring and experimentation (if warranted) could be focused (Healey 2001).

Conceptual models can be used in conjunction with indicators to help us understand how actions may have affected the environment. Development and refinement of performance measures, a type of indicator, can establish measurable expectations of program performance (Healey 2001). The structured analysis needs to be sufficiently quantitative (Healy 2001). Because any quantitative estimates will be uncertain, it is probably best to represent them as a probability distribution or expected outcomes. However, without clear, a priori specifications of quantitative expectations, it is very difficult to judge restoration progress objectively. Quantitatively measured responses would be considered in conjunction with “trigger points,” values or conditions of a variable that would initiate a re-evaluation of certain restoration actions or the plan as a whole (Healey 2001). The use of trigger points is shown in figure 2.

On the technical level, performance measures help inform science on ecological effects and needs for monitoring and adaptive management; however, performance measures also can inform managers on program and policy decisions and future regulatory objectives, such as milestones or the equivalent. The ERP has been relying on general-level measures and regulatory milestones to assess program progress, and needs more-refined metrics to address ecosystem goals and objectives defined in the ERPP and MSCS. Performance measures must be defined for these goals and objectives, and protocols developed to ascertain whether the objectives are being met. Composite or generalized performance measures are useful for informing the public on program progress and success. Lastly, performance measures from other program elements can inform the ERP and CALFED managers on those elements’ success in contributing to ecosystem restoration.

Work is being coordinated between the performance measures subcommittee and existing performance measures ecosystem subgroup. Ecosystem liaisons from the CALFED Independent Science Board (ISB), in cooperation with the CALFED Science Program, are helping develop framework documents and assist in development of technical and communication products. Coordination with ISB and Science Program will ensure scientific integrity and help ensure that these ERP activities are relevant and productive.

Needs for monitoring, adaptive management, and performance measures presently are being addressed by ERP staff during end of Stage 1 assessments of the MSCS, ERP milestones, and other ecosystem goals and objectives. Development of monitoring, adaptive management, and performance measures will be linked with the DRERIP AMPT, which will provide conceptual models to inform ERP planners on ecological processes, habitats, stressors, and species life history. The AMPT presently is entering peer review phases of conceptual model development.

Because monitoring is directly linked to performance measures, and both are critical for the ERP to track its progress on ecosystem restoration, assess restoration actions, and implement adaptive management, it is necessary to coordinate these efforts with CMARP. The ERP agencies see CMARP as the logical vehicle to meet outstanding needs within the larger Ecosystem Restoration Program Objective. CMARP can function as the bridge between the largely management-driven performance measures effort, and the conceptual modeling effort currently underway within DRERIP (Figure 3). CMARP can help provide planning for monitoring and assessment, and is seen by the ERP as a critical element of adaptive management.

Similarly, CMARP can be an instrument to coordinate ongoing monitoring efforts within the IEP with those that arise from ERP performance measures work. The ongoing IEP and POD investigations are developing data and indicators on status and function of the Bay-Delta. These programs should confer with DRERIP on respective goals and objectives and coordinate efforts to most efficiently address the range of environmental indicators and performance measures needed, maximize use of information, and avoid duplication of effort. IEP monitoring results and insights on Delta ecological processes and conditions can further support ERP needs by tracking progress toward ERP goals and objectives, and reviewing program actions for implementation and adaptive management.

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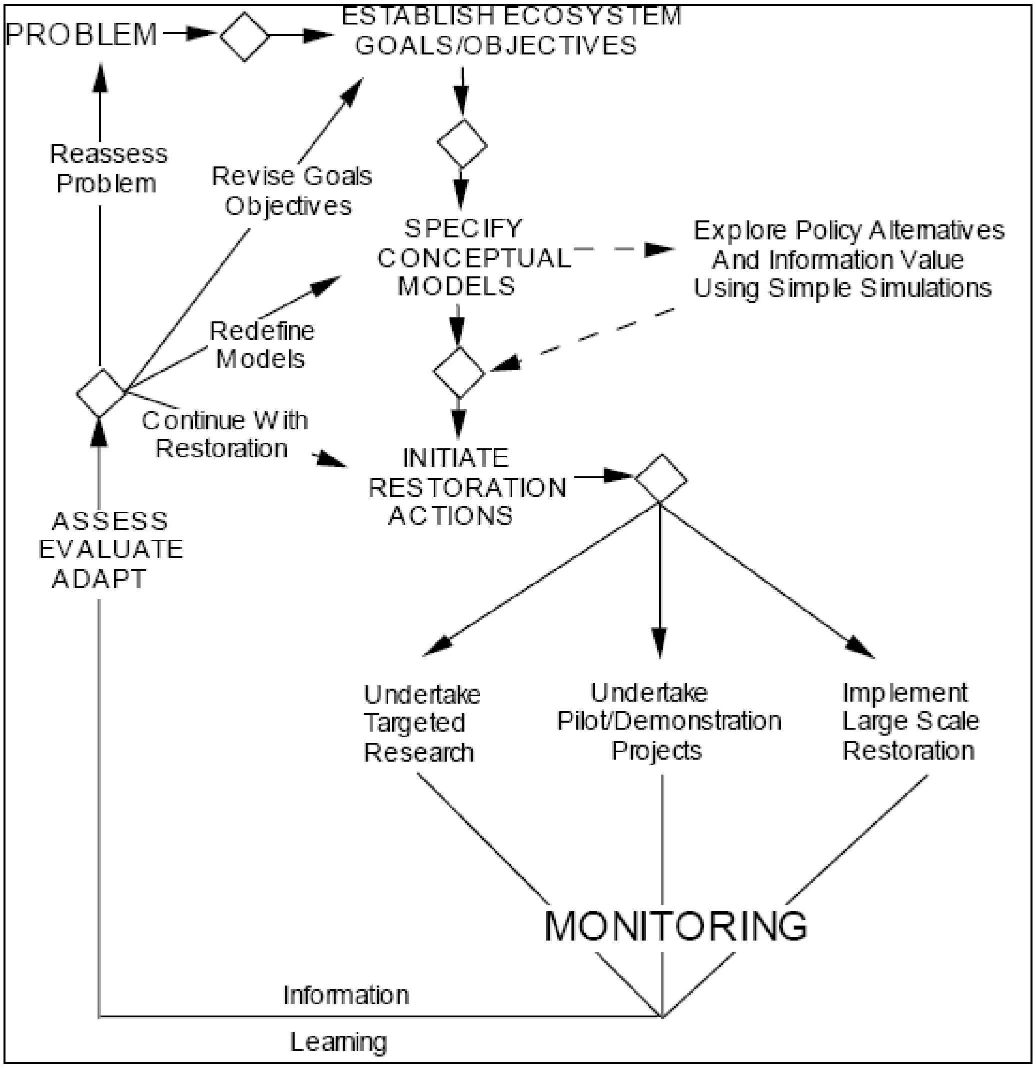


Figure 1. Diagram of the adaptive management process (CALFED 2000).

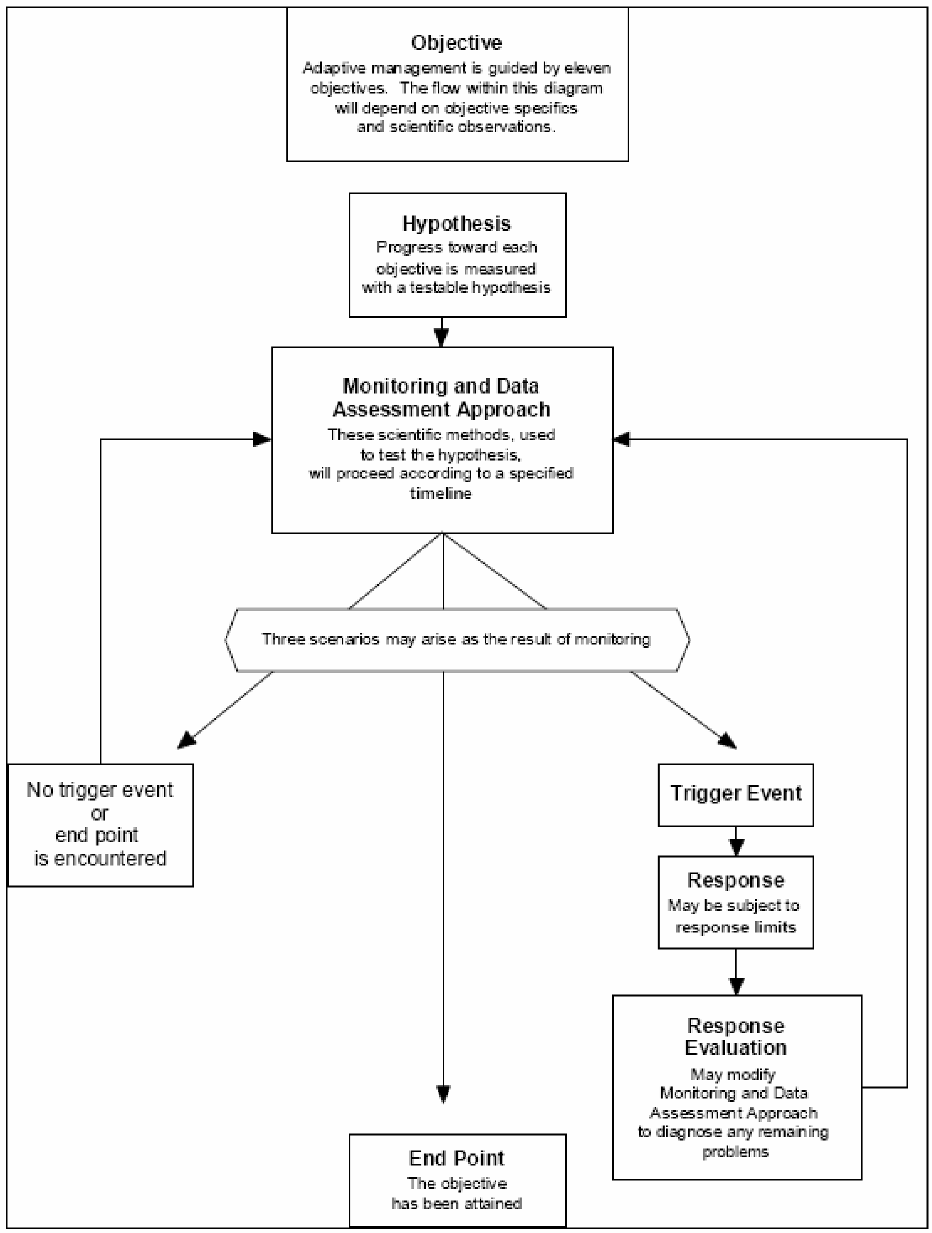


Figure 2. Flow chart showing components of adaptive management objectives and the general relationships between components (From USBR and SWRCB 2003).

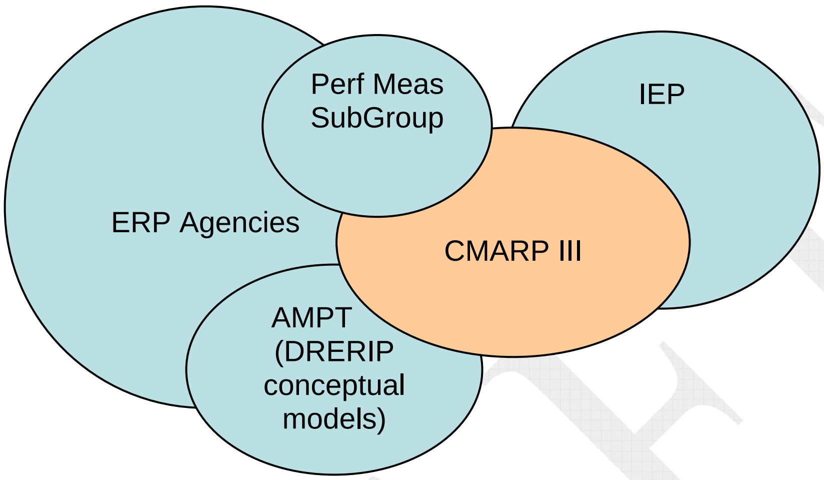
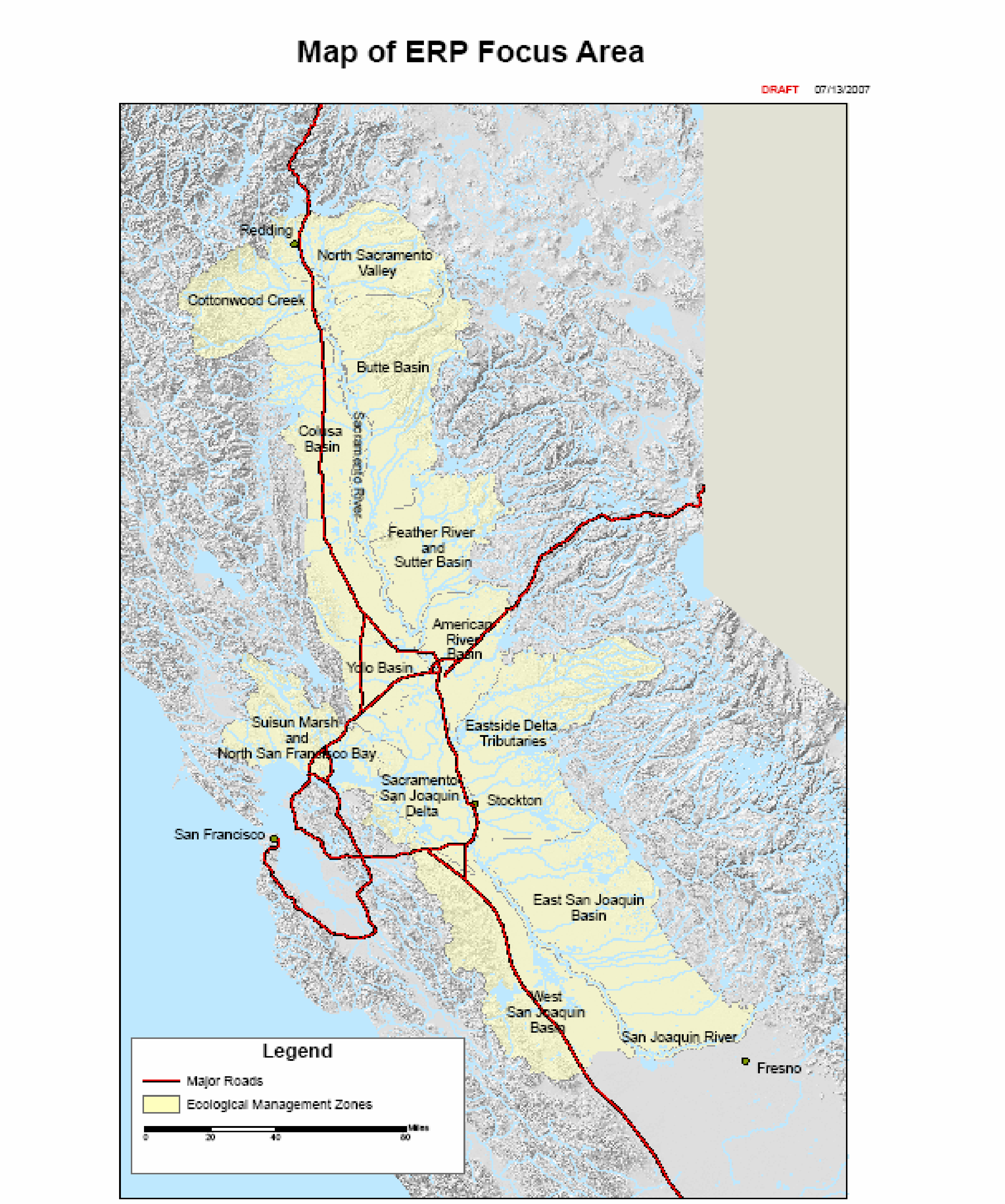


Figure 3: CMARP can be the Bridge among monitoring, adaptive management, conceptual models, and quantitative performance measures.

APPENDIX A


Map of ERP Focus Area
DRAFT 07/13/2007
Redding
North Sacramento Valley
Cottonwood Creek
Butte Basin
Colusa Basin
Sacramento River
Feather River and Sutter Basin
American River Basin
Yolo Basin
Suisun Marsh and North San Francisco Bay
Eastside Delta Tributaries
Sacramento San Joaquin Delta
Stockton
San Francisco
East San Joaquin Basin
West San Joaquin Basin
San Joaquin River
Fresno
Legend
Major Roads
Ecological Management Zones
Miles
0
20
40
80

APPENDIX B

ERP STRATEGIC GOALS AND OBJECTIVES

GOAL 1. ENDANGERED AND OTHER AT-RISK SPECIES AND NATIVE BIOTIC COMMUNITIES: Achieve recovery of ac-risk native species dependent on the Delta and Suisun Bay as the first step toward establishing large, self-sustaining populations of these species; support similar recover of at-risk native species in San Francisco Bay and the watershed above the estuary; and minimize the need for future endangered species listings by reversing downward population trends of native species that are not listed.

OBJECTIVE 1: Achieve, first, recovery and then large self-sustaining populations of the following at-risk native species dependent on the Delta, Suisun Bay and Suisun Marsh, with emphasis on Central Valley winter-, spring- and fall/late fall-run Chinook salmon ESUs, Central Valley steelhead ESU, delta smelt, longfin smelt, Sacramento splittail, green sturgeon, valley elderberry longhorn beetle, Suisun ornate shrew, Suisun song sparrow, soft bird's-beak, Suisun thistle, Mason's lilaeopsis, San Pablo song sparrow, Lange's metalmark butterfly, Antioch Dunes evening primrose, Contra Costa wallflower, and Suisun marsh aster.

OBJECTIVE 2: Contribute to the recovery of the following at-risk native species in the Bay-Delta estuary and its watershed: Sacramento perch, delta green ground beetle, giant garter snake, salt marsh harvest mouse, riparian brush rabbit, San Pablo California vole, San Joaquin Valley woodrat, least Bell's vireo, California clapper rail, California black rail, little willow flycatcher, bank swallow, western yellow-billed cuckoo, greater sandhill crane, Swainson's hawk, California yellow warbler, salt marsh common yellowthroat, Crampton's tuctoria, Northern California black walnut, delta tule pea, delta mudwort, bristly sedge, delta coyote thistle, alkali milkvetch, and Point Reyes bird's-beak.

OBJECTIVE 3: Enhance and/or conserve native biotic communities in the Bay-Delta estuary and its watershed, including the abundance and distribution of the following biotic assemblages and communities: native resident estuarine and freshwater fish assemblages, anadromous lampreys, neotropical migratory birds, wading birds, shore birds, waterfowl, native anuran amphibians, estuarine plankton assemblages, estuarine and freshwater marsh plant communities, riparian plant communities, seasonal wetland plant communities, vernal pool communities, aquatic plant communities, and terrestrial biotic assemblages associated with aquatic and wetland habitats.

OBJECTIVE 4: Maintain the abundance and distribution of the following species: hardhead, western least bittern, California tiger salamander, western spadefoot toad, California red-legged frog, western pond turtle, California freshwater shrimp, recurved larkspur, mad-dog skullcap, rose-mallow, eel-grass pondweed, Colusa grass, Boggs Lake hedge-hyssop, Contra Costa goldfields, Greene's legenere, heartscale, and other species designated "maintain" in the Multi-Species Conservation Strategy.

GOAL 2. ECOLOGICAL PROCESSES: Rehabilitate natural processes in the Bay-Delta estuary and its watershed to fully support, with minimal ongoing human intervention, natural aquatic and associated terrestrial biotic communities and habitats, in ways that favor native members of those communities.

OBJECTIVE 1: Establish and maintain hydrologic and hydrodynamic regimes for the Bay and Delta that support the recovery and restoration of native species and biotic communities, support the restoration and maintenance of functional natural habitats, and maintain harvested species.

OBJECTIVE 2: Increase estuarine productivity and rehabilitate estuarine food web processes to support the recovery and restoration of native estuarine species and biotic communities.

OBJECTIVE 3: Rehabilitate natural processes to create and maintain complex channel morphology, in-channel islands, and shallow water habitat in the Delta and Suisun Marsh.

OBJECTIVE 4: Create and/or maintain flow and temperature regimes in rivers that support the recovery and restoration of native aquatic species.

OBJECTIVE 5: Establish hydrologic regimes in streams, including sufficient flow timing, magnitude, duration, and high flow frequency, to maintain channel and sediment conditions supporting the recovery - and restoration of native aquatic and riparian species and biotic communities.

OBJECTIVE 6: Reestablish floodplain inundation and channel-floodplain connectivity of sufficient frequency, timing, duration, and magnitude to support the restoration and maintenance of functional natural floodplain, riparian, and riverine habitats.

GOAL 3. HARVESTED SPECIES: Maintain and/or enhance populations of selected species for sustainable commercial and recreational harvest, consistent with the other ERP strategic goals.

OBJECTIVE 1: Enhance fisheries for salmonids, white sturgeon, pacific herring, and native cyprinid fishes.

OBJECTIVE 2: Maintain, to the extent consistent with ERP goals, fisheries for striped bass, American shad, signal crayfish, grass shrimp, and nonnative warmwater game fishes.

OBJECTIVE 3: Enhance, to the extent consistent with ERP goals, populations of waterfowl and upland game for harvest by hunting and for non-consumptive recreation.

OBJECTIVE 4: Ensure that Chinook-salmon, steelhead, trout, and striped bass hatchery, rearing, and planting programs do not have detrimental effects on wild populations of native fish species and ERP actions.

GOAL 4. HABITATS: Protect and/or restore functional habitat types in the Bay-Delta estuary and its watershed for ecological and public values such as supporting species and biotic communities, ecological processes, recreation, scientific research, and aesthetics.

OBJECTIVE 1: Restore large expanses of all major habitat types, and sufficient connectivity among habitats, in the Delta, Suisun Bay, Suisun Marsh, and San Francisco Bay to support recovery and restoration of native species and biotic communities and rehabilitation of ecological processes. These habitat types include tidal marsh (fresh, brackish, and saline), tidal perennial aquatic (including shallow water and tide flats), nontidal perennial aquatic, tidal sloughs, mid-channel island and shoal, seasonal wetlands, riparian and shaded riverine aquatic, inland dune scrub, upland scrub, and perennial grasslands.

OBJECTIVE 2: Restore large expanses of all major aquatic, wetland, and riparian habitats, and sufficient connectivity among habitats, in the Central Valley and its rivers to support recovery and restoration of native species and biotic communities and rehabilitation of ecological processes. These habitat types include riparian and shaded riverine aquatic, instream, fresh emergent wetlands, seasonal wetlands, other floodplain habitats, lacustrine, and other freshwater fish habitats.

OBJECTIVE 3: Protect tracts of existing high quality major aquatic, wetland, and riparian habitat types, and sufficient connectivity among habitats, in the Bay-Delta estuary and its watershed to support recovery and restoration of native species and biotic communities, rehabilitation of ecological processes, and public value functions.

OBJECTIVE 4: Minimize the conversion of agricultural land to urban and suburban uses and maintain open space buffers in areas adjacent to existing and future restored aquatic, riparian, and wetland habitats, and manage agricultural lands in ways that are favorable to birds and other wildlife. OBJECTIVE 5: Manage the Yolo and Sutter Bypasses as major areas of seasonal shallow water habitat to enhance native fish and wildlife, consistent with CALFED Program objectives and solution principles.

GOAL 5. NONNATIVE INVASIVE SPECIES: Prevent the establishment of additional non-native invasive species and reduce the negative ecological and economic impacts of established non-native species in the Bay-Delta estuary and its watershed.

OBJECTIVE 1: Eliminate further introductions of new species from the ballast water of ships into the Bay-Delta estuary.

OBJECTIVE 2: Eliminate further introductions of new species from imported marine and freshwater baits into the Bay-Delta estuary and its watershed.

OBJECTIVE 3: Halt the unauthorized introduction and spread of potentially harmful non-native
introduced species of fish or other aquatic organisms in the Bay-Delta and Central Valley.

OBJECTIVE4: Halt the release of non-native introduced fish and other aquatic organisms from private aquaculture operations and the aquarium and pet trades into the Bay-Delta estuary, its watershed, and other California waters.

OBJECTIVE 5: Halt the introduction of non-native invasive aquatic and terrestrial plants into the Bay- Delta estuary, its watershed, and other central California waters.

OBJECTIVE 6: Reduce the impact of non-native mammals on native birds, mammals, and other organisms.

OBJECTIVE 7: Limit the spread or, when possible and appropriate, eradicate populations of non-native invasive species through focused management efforts.

OBJECTIVE 8: Prevent the invasion of the zebra mussel into California.

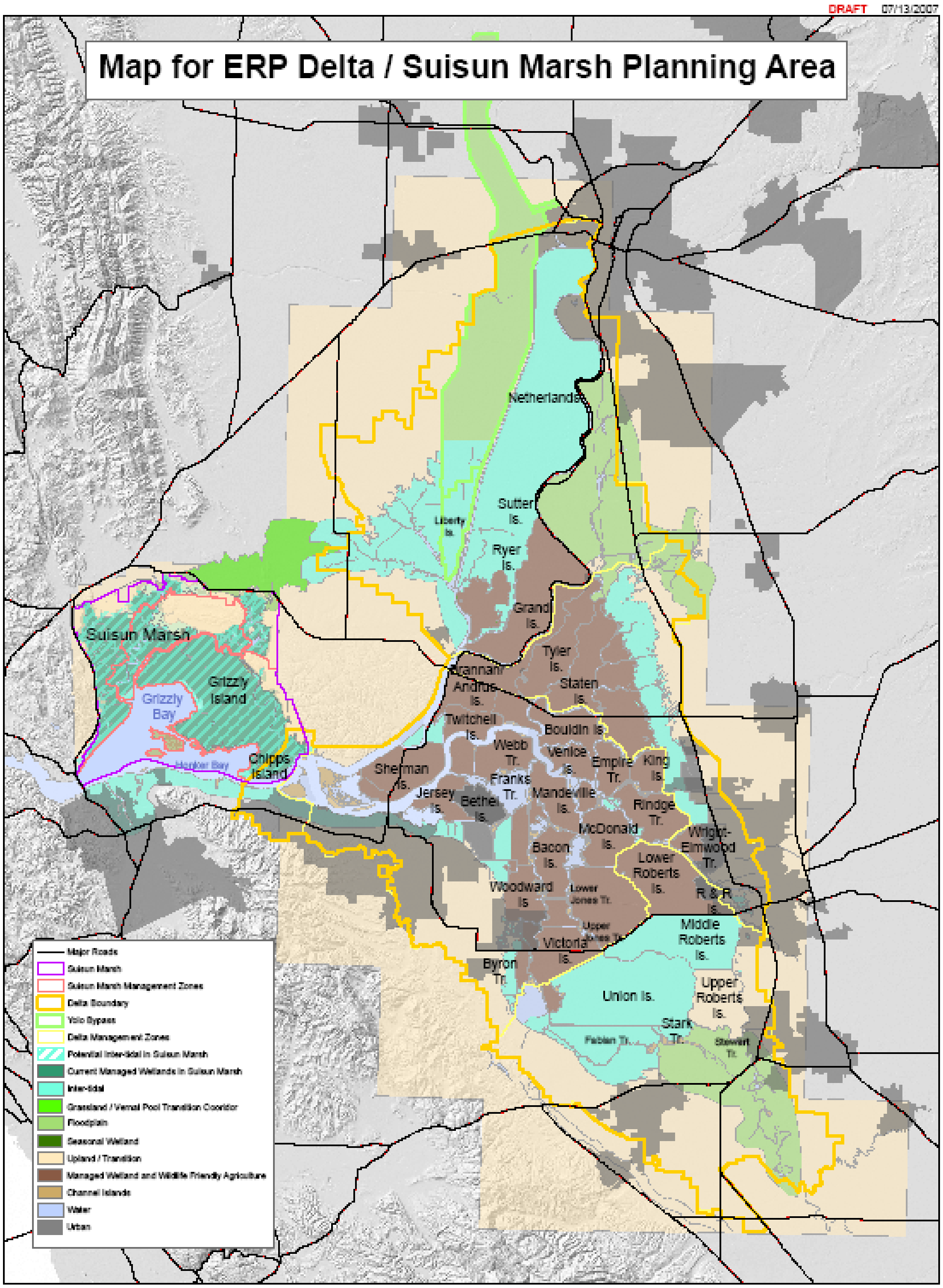
GOAL 6. WATER AND SEDIMENT QUALITY: Improve and/or main rain water and sediment quality conditions that fully support healthy and diverse aquatic ecosystems in the Bay-Delta estuary and watershed; and eliminate, to the extent possible, toxic impacts to aquatic organisms, wildlife, and people.

OBJECTIVE 1: Reduce the loadings and concentrations of toxic contaminants in all aquatic environments in the Bay-Delta estuary and watershed to levels that do not adversely affect aquatic organisms, wildlife, and human health.

OBJECTIVE 2: Reduce loadings of oxygen-depleting substances from human activities into aquatic ecosystems in the Bay-Delta estuary and watershed to levels that do not cause adverse ecological effects.

OBJECTIVE 3: Reduce fine sediment loadings from human activities into rivers and streams to levels that do not cause adverse ecological effects.

APPENDIX C



DRAFT 07/13/2007
Map for ERP Delta / Suisun Marsh Planning Area
Netherlands
Sutter Is.
Liberty Is.
Ryer Is.
Grand Is.
Tyler Is.
Staten Is.
Brannan Andrus Is.
Twitchell Is.
Bouldin Is.
Webb Tr.
Venice Is.
Empire Tr.
King Is.
Sherman Is.
Franks Tr.
Jersey Is.
Bethel Is.
Mandeville Is.
Rindge Tr.
McDonald Is.
Wright-Elmwood Tr.
Bacon Is.
Lower Roberts Is.
Woodward Is.
Lower Jones Tr.
R & R Is.
Upper Jones Tr.
Middle Roberts Is.
Victoria Is.
Byron Tr.
Union Is.
Upper Roberts Is.
Fabian Tr.
Stark Tr.
Stewart Tr.
Suisun Marsh
Grizzly Island
Grizzly Bay
Honker Bay
Chipps Island
Major Roads
Suisun Marsh
Suisun Marsh Management Zones
Delta Boundary
Yolo Bypass
Delta Management Zones
Potential Inter-tidal in Suisun Marsh
Current Managed Wetlands in Suisun Marsh
Inter-tidal
Grassland / Vernal Pool Transition Corridor
Floodplain
Seasonal Wetland
Upland / Transition
Managed Wetland and Wildlife Friendly Agriculture
Channel Islands
Water
Urban